# Total Maximum Daily Loads of Nitrogen for Three Tidal Tributaries and Total Maximum Daily Load of Biochemical Oxygen Demand for One Tributary in the Newport Bay System Worcester County, Maryland

**FINAL**

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## List of Abbreviations

| | |
|---|---|
| 7Q10 | 7-day consecutive lowest flow expected to occur every 10 years |
| BMP | Best Management Practice |
| BOD | Biochemical Oxygen Demand |
| CCMP | Comprehensive Conservation Management Plan for Maryland's Coastal Bays |
| CEAM | Center for Exposure Assessment Modeling |
| CHL*a* | Active Chlorophyll |
| COMAR | Code of Maryland Regulations |
| CWAP | Clean Water Action Plan |
| CZM 6217 | Federal Coastal Zone Management Act ; Coastal Nonpoint Pollution Control Programs |
| DIN | Dissolved Inorganic Nitrogen |
| DIP | Dissolved Inorganic Phosphorus |
| DNR | Maryland Department of Natural Resources |
| DO | Dissolved Oxygen |
| EPA | Environmental Protection Agency |
| EUTRO5.1 | Eutrophication Module of WASP5.1 |
| $km^2$ | Square Kilometers |
| LA | Load Allocation |
| LILAC | Low Income Loans for Agricultural Conservation |
| lbs/acre | Pounds Per Acre |
| lbs/day | Pounds Per Day |
| lbs/month | Pounds Per Month |
| lbs/yr | Pounds Per Year |
| MACS | Maryland Agriculture Cost Share Program |
| MCBP | Maryland Coastal Bays Program |
| MDE | Maryland Department of the Environment |
| MOS | Margin of Safety |
| mg/l | Milligrams Per Liter |
| µg/l | Microgram Per Liter |
| NBEM | Newport Bay Eutrophication Model |
| NBOD | Nitrogenous Biochemical Oxygen Demand |
| NEP | National Estuaries Program |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint Source |
| ON | Organic Nitrogen |
| OP | Organic Phosphorus |
| $PO_4$ | Ortho-Phosphate |
| SOD | Sediment Oxygen Demand |

| | |
|---|---|
| TMDL | Total Maximum Daily Load |
| UMCES | University of Maryland Center for Environmental Science |
| USGS | United States Geological Survey |
| WASP5.1 | Water Quality Analysis Simulation Program 5.1 |
| WLA | Waste Load Allocation |
| WQIA | Water Quality Improvement Act |
| WQLS | Water Quality Limited Segment |
| WRAS | Watershed Restoration Action Strategy |
| WWTP | Waste Water Treatment Plant |

## EXECUTIVE SUMMARY

This document establishes Total Maximum Daily Loads (TMDLs) for four portions of the Newport Bay system: Ayer Creek, Newport Creek, Newport Bay mainstem and Kitts Branch. Newport Bay (basin code 02-13-01-05) was identified on the State's 1996 list of water quality limited segments (WQLSs) submitted to the U.S. Environmental Protection Agency (EPA) by Maryland Department of the Environment (MDE) as impaired by nutrients and fecal coliform. The TMDLs described within this document were developed to address localized water quality impairments identified within these four portions of the watershed; the fecal coliform in these portions of the Newport Bay watershed and nutrient impairments in other portions of the watershed will be addressed at a future date.

Newport Bay is located in the northeast section of Worcester County, Maryland and includes Ayer Creek, Kitts Branch, Marshall Creek[*], Newport Creek and Newport Bay mainstem (including Trappe Creek). The TMDLs were determined using the Water Quality Analysis Simulation Program Version 5.1 (WASP5.1). The water quality goals of the TMDLs proposed in this report are to reduce high chlorophyll *a* concentrations (a surrogate for algal blooms), and to maintain the dissolved oxygen (DO) criterion at a level whereby the designated uses will be met. To begin addressing these impairments, this document proposes to establish TMDLs for the nutrient nitrogen in the tributaries and mainstem of Newport Bay. In Kitts Branch, a biochemical oxygen demand (BOD) TMDL is being established under spring and summer low-flow conditions. All of the TMDLs include both implicit margins of safety (MOSs), developed through conservative modeling assumptions, and explicit MOSs.

*Nitrogen TMDLs*

Based on recent sampling, Ayer Creek and Newport Creek (tributaries of Newport Bay) as well as the Newport Bay mainstem were determined to be impaired by nutrients, which cause excessive algal blooms and violations of the DO criterion. Modeling analyses indicated that nitrogen is the cause of excessive algal growth in the Newport Bay System. Therefore, a loading cap on nitrogen entering the Newport Bay System is established for all flow conditions.

The TMDLs for Ayer Creek, Newport Creek, and Newport Bay mainstem are established for all flow conditions in the system: summer stream flow, which represents the critical conditions during low flow; spring stream flow, which represents the conditions during moderate flow and winter stream flow, which represents a critical high flow situation with conditions suitable for algal growth. Establishing these TMDLs under various flow regimes ensures that critical conditions and seasonal variations are addressed.

[*] A TMDL analysis for Marshall Creek is not included in this report.

For Ayer Creek, which drains to the Newport Bay mainstem, the TMDL allocations for nitrogen are provided in the table below:

| TMDL Allocations of Nitrogen for Ayer Creek | Summer Flow June 1 – Oct. 31 | Spring Flow April 1 – May 31 | Winter Flow Nov. 1 – March 31 |
|---|---|---|---|
| **Point Source Load** | 0 lbs/month | 0 lbs/month | 0 lbs/month |
| **Nonpoint Source Load** | 204 lbs/month | 1,733 lbs/month | 1,981 lbs/month |
| **Margin of Safety (MOS)** | 11 lbs/month | 91 lbs/month | 104 lbs/month |
| **Total Maximum Daily Load (TMDL)** | 215 lbs/month | 1,824 lbs/month | 2,085 lbs/month |

There are no point sources located in the Ayer Creek watershed; hence, there are no allocations to point sources.

For Newport Creek, which drains to the Newport Bay mainstem, the TMDL allocations for nitrogen are provided in the table below.

| TMDL Allocations of Nitrogen for Newport Creek | Summer Flow June 1 – Oct. 31 | Spring Flow April 1 – May 31 | Winter Flow Nov. 1 – March 31 |
|---|---|---|---|
| **Point Source Load** | 0 lbs/month | 0 lbs/month | 0 lbs/month |
| **Nonpoint Source Load** | 266 lbs/month | 2,084 lbs/month | 2,741 lbs/month |
| **Margin of Safety (MOS)** | 14 lbs/month | 110 lbs/month | 145 lbs/month |
| **Total Maximum Daily Load (TMDL)** | 280 lbs/month | 2,194 lbs/month | 2,886 lbs/month |

There are no point sources located in the Newport Creek watershed; hence, there are no allocations to point sources.

For Newport Bay, the TMDL allocations for nitrogen are provided in the table below.

| TMDL Allocations of Nitrogen for Newport Bay | Summer Flow June. 1 – Oct. 31 | Spring Flow April 1 – May 31 | Winter Flow Nov. 1 – March 31 |
|---|---|---|---|
| **Point Source Load** | 877 lbs/month | 1,626 lbs/month | 9,653 lbs/month |
| **Nonpoint Source Load** | 3,451 lbs/month | 14,817 lbs/month | 21,506 lbs/month |
| **Margin of Safety (MOS)** | 163 lbs/month | 759 lbs/month | 1,111 lbs/month |
| **Total Maximum Daily Load (TMDL)** | 4,491 lbs/month | 17,202 lbs/month | 32,270 lbs/month |

*BOD TMDL*

Recent monitoring data indicate that BOD impairs Kitts Branch of the Newport Bay system as shown by low DO levels under summertime low-flow conditions. In addition, the model shows the DO level in Kitts Branch is sensitive to the BOD discharge from the major point source in the tributary. Therefore, a loading cap on BOD entering Kitts Branch of the Newport Bay system is established for spring and summertime low-flow conditions.

For Kitts Branch, the TMDL allocations for BOD are provided below.

| TMDL Allocations of BOD for Kitts Branch | Summer Flow June 1 – Oct. 31 | Spring Flow April 1 – May 31 |
|---|---|---|
| **Point Source Load** | 1,300 lbs/month | 4,650 lbs/month |
| **Nonpoint Source Load** | 66 lbs/month | 1,408 lbs/month |
| **Margin of Safety (MOS)** | 3 lbs/month | 74 lbs/month |
| **Total Maximum Daily Load (TMDL)** | 1,369 lbs/month | 6,132 lbs/month |

Five factors provide assurance that these nitrogen and BOD TMDLs will be implemented. First, National Pollutant Discharge Elimination System (NPDES) permits will assure implementation of the waste load allocations. Second, Maryland's Water Quality Improvement Act of 1998 requires that nutrient management plans be implemented for all agricultural lands throughout Maryland. Third, the Clean Water Act Amendment of 1990 assures that a load reduction on nitrogen will be achieved if it is fully implemented. Fourth, the Maryland Coastal Bays Program has invested years of technical investigation and community involvement to protect the future of the bays. This has been formalized in the creation of a comprehensive plan to restore and protect Maryland's Coastal Bays. Finally, Maryland has adopted a watershed cycling strategy, which will assure that routine future monitoring and TMDL evaluations are conducted.

## 1.0 INTRODUCTION

Section 303(d)(1)(C) of the federal Clean Water Act and U.S. Environmental Protection Agency (EPA)'s implementing regulations direct each State to develop a Total Maximum Daily Load (TMDL) for each impaired water quality limited segment (WQLS) on the Section 303(d) list, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty. A TMDL reflects the total pollutant loading of an impairing substance a waterbody can receive and still meet water quality standards.

TMDLs are established to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

Newport Bay was first identified on the 1996 303(d) list submitted to the EPA by the Maryland Department of the Environment (MDE) as being impaired by fecal coliform and nutrients due to signs of eutrophication (expressed as high chlorophyll *a* levels). The fecal coliform impairment will be addressed at a later date. The 1996 list acknowledges that "impairments may be very localized," indicating that spatial refinement of impairments could come about "as the State develops additional information" during the TMDL analysis. As a result of such additional information, the Newport Bay has been partitioned into five different sub-watersheds. The following outline identifies these five sub-watersheds:

<u>Five Sub-watersheds in the Newport Bay System</u>

- Ayer Creek
- Kitts Branch
- Marshall Creek*
- Newport Creek
- Newport Bay (includes Trappe Creek)

Due to limitations of data and the water quality analysis models, TMDLs for Marshall Creek are not being established at this time; however, they will be developed in the future.

*Nitrogen TMDLs*

MDE is proposing three separate nitrogen TMDLs for Ayer Creek, Newport Creek and the Newport Bay mainstem (including Trappe Creek). These waters are impaired by nutrients due to signs of eutrophication, which are expressed as high chlorophyll *a* and low dissolved oxygen (DO). Eutrophication is the over-enrichment of aquatic systems by excessive inputs of nutrients (nitrogen and/or phosphorus). Nutrients act as a fertilizer leading to excessive growth of aquatic

* The asterisks denote waters for which TMDL analyses are not conducted in this report.

plants. Algae eventually die and decompose, leading to bacterial consumption of DO. Analyses indicate that algal growth is limited by the availability of nitrogen in the Newport Bay System. For this reason, it is possible to eliminate the impairment by limiting the amount of nitrogen entering the waterbody, without regard to the loadings of other nutrients.

*BOD TMDL*

MDE is proposing one BOD TMDL for Kitts Branch. BOD impairs this sub-watershed as indicated by low DO under summertime low-flow conditions.

## 2.0 SETTING AND WATER QUALITY DESCRIPTION

### 2.1 General Setting and Source Assessment

Newport Bay is a shallow coastal lagoon located west of Sinepuxent Bay on the Atlantic Coast of Worcester County, Maryland (Figure 1). Newport Bay consists of the main bay and several tributaries: Ayer Creek, Trappe Creek, Newport Creek and Marshall Creek. Kitts Branch drains to Trappe Creek. The majority of the freshwater input to the system comes from the upper part of the basin ultimately draining to Chincoteague Bay. The Newport Bay watershed occupies an area of approximately 27,213 acres (110 $km^2$). The open surface water area accounts for an additional 5,279 acres (21 $km^2$). Most of the Newport Bay watershed is on the mainland of the Delmarva Peninsula and a small barrier island makes up the remainder. The watershed is characterized by low topographic relief, high groundwater tables, poor surface drainage and sandy soils.

The following sections provide information on land use and annual point and nonpoint source (NPS) loads for Newport Bay mainstem including Trappe Creek, Ayer Creek, Newport Creek and Kitts Branch. Figure 2 shows the geographic distribution of the different land uses throughout the Newport Bay watershed. Figures 3a – 3d show the relative distribution of various land uses within the drainage areas of the main bay and Trappe Creek, Kitts Branch and the remaining tidal tributaries addressed by these TMDL analyses. The land use information is based on 1997 Maryland Office of Planning land cover data, and 1997 Farm Service Agency data.

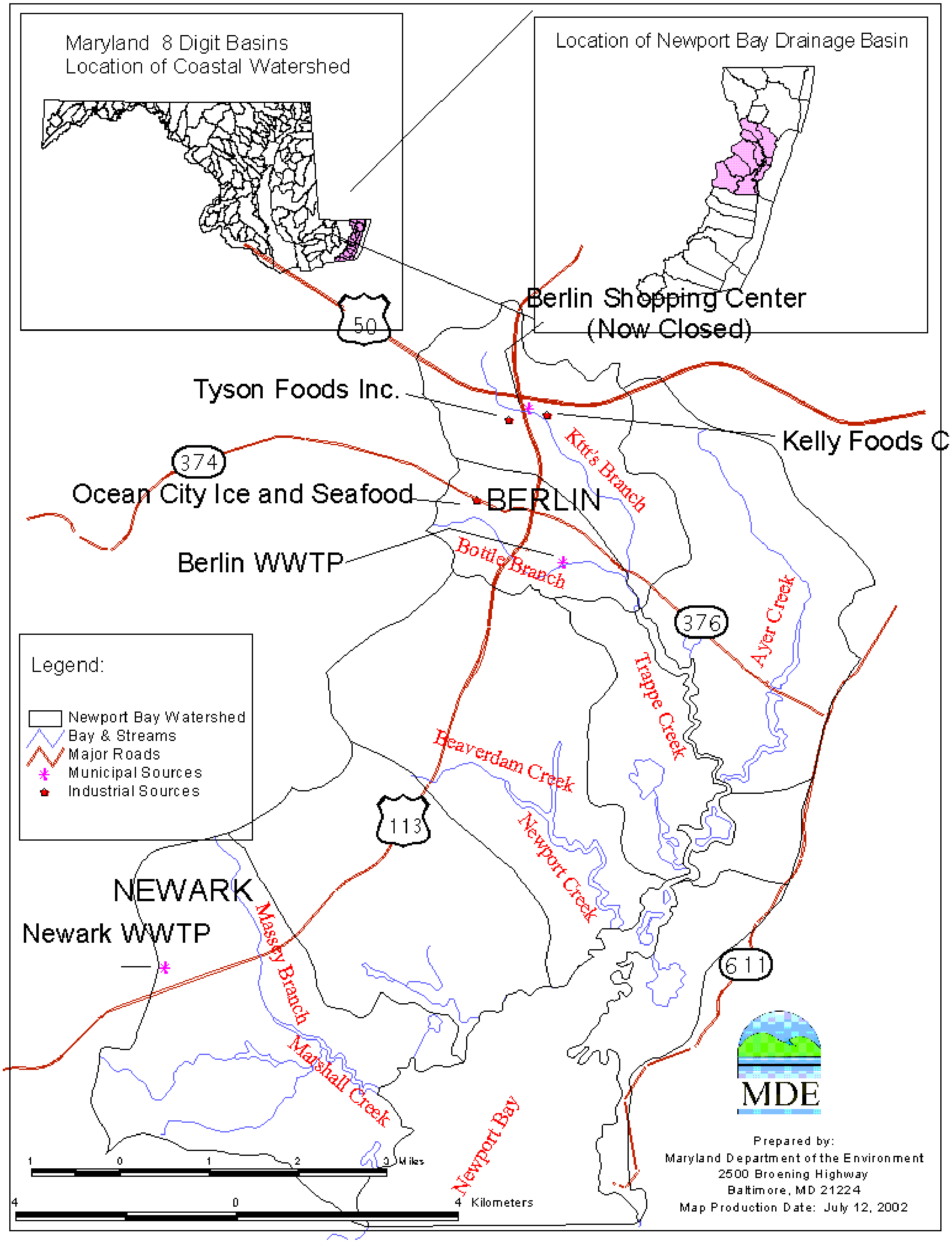


**Figure 1: Location Map of the Newport Bay Drainage Basin within Maryland**

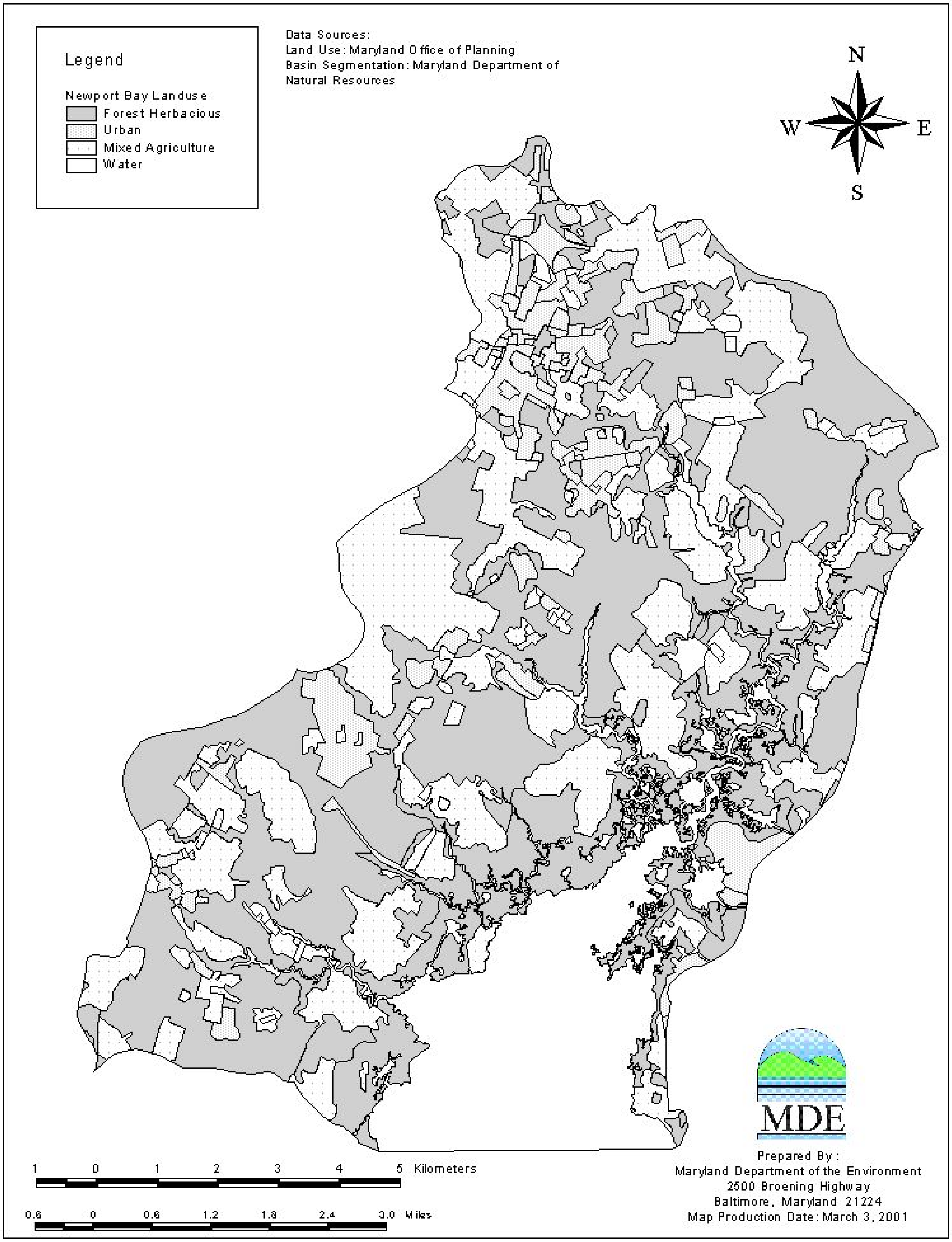


**Figure 2: Land Use in the Newport Bay Drainage Basin**

The average annual NPS loads presented below are the baseline loads relative to which the average annual TMDL loadings can be compared. The baseline average annual NPS load was calculated by summing all of the individual land use areas and multiplying by the corresponding land use loading coefficients, as described further in Appendix A. The baseline loading coefficients were based on a study conducted in the Maryland Coastal Bays (University of Maryland, 1993). In addition, direct groundwater contributions are estimated, which represent inflow from the shoreline and bottom of tidal waterbodies. Figures 4a – 4c in the following section show the relative distribution of average annual NPS nitrogen and phosphorus loads attributable to various land uses for each of the major watersheds addressed by this analysis. Two point sources are addressed explicitly by TMDL allocations in this analysis, which are discussed in Section 2.1.4.

*Nitrogen TMDLs*

### 2.1.1 Ayer Creek

Ayer Creek has a drainage area of 3,780 acres (15.3 $km^2$). The land uses in the watershed consist of forest and other herbaceous (1,707 acres or 45 %), mixed agriculture (1,603 acres or 44 %), and urban (275 acres or 7%). The water surface area of Ayer Creek is 134 acres (0.5 $km^2$). Figure 3a shows the relative amounts of the different land uses in the Ayer Creek watershed.

In the Ayer Creek watershed, the baseline average annual total nitrogen load is 33,455 lbs/yr. Direct atmospheric deposition to the water's surface accounts for approximately 2% of the load, and direct groundwater discharge accounts for approximately 10% of the load (USGS, 2002). The estimated average annual total phosphorus load is 3,853 lbs/yr. There are no significant point source dischargers of nutrients in the Ayer Creek watershed, and thus the total load is due to nonpoint sources. Figure 4a shows the relative contributions of nitrogen and phosphorus from the various sources.

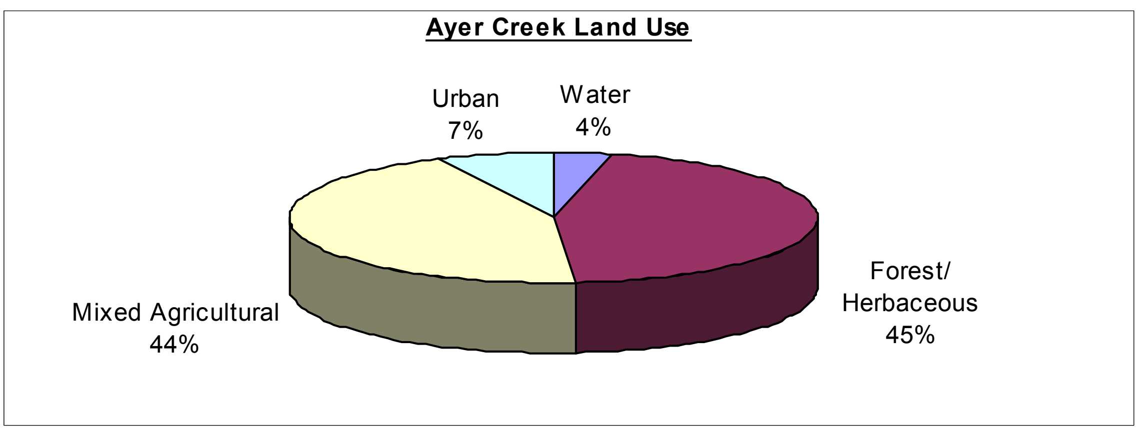


**Figure 3a: Land Use in the Ayer Creek Watershed**

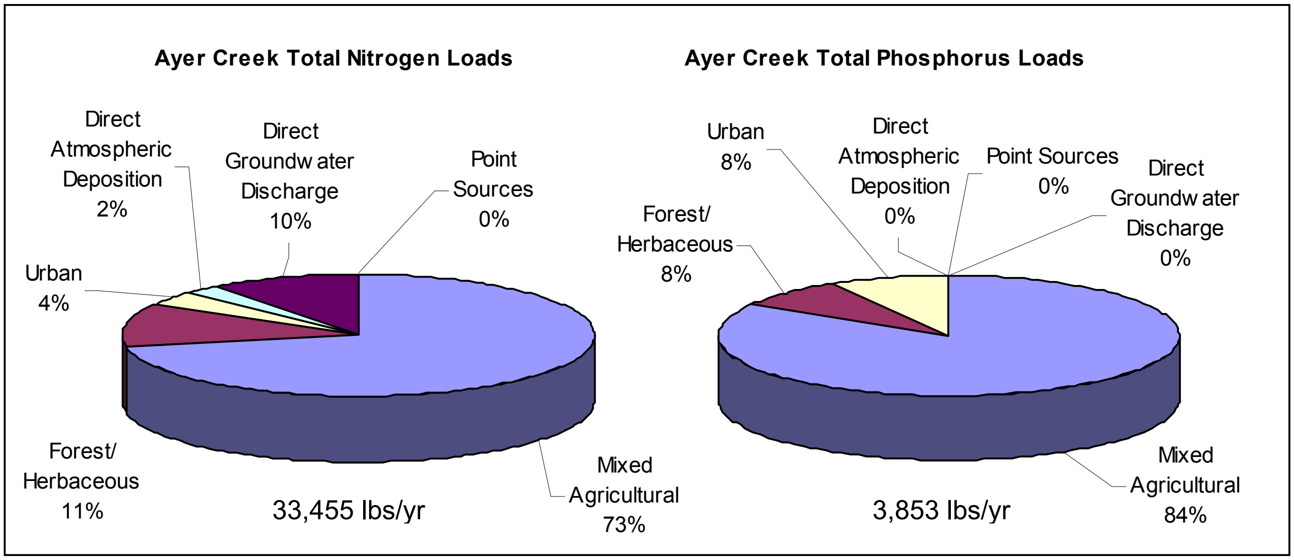


**Figure 4a: Average Annual Total Nitrogen and Total Phosphorus Loads Entering Ayer Creek**

### 2.1.2 Newport Creek

Newport Creek, a significant tidal creek in the Newport Bay, drains a watershed area of approximately 5,240 acres (21.2 km$^2$). Land use in the watershed consists of mixed agriculture (1,808 acres or 9 %), forest and other herbaceous cover (2,883 acres or 55%), and urban (329 acres or 6 %). The water surface area of Newport Creek is 2,221 acres (0.9 km$^2$, 4%). Figure 3b shows the relative amounts of the different land uses in Newport Creek.

In the Newport Creek watershed, the baseline average annual total nitrogen load is 44,510 lbs/yr. Direct atmospheric deposition to the water's surface accounts for approximately 2% of the load, and direct groundwater discharge accounts for approximately 21% of the load (USGS, 2002). The estimated average annual total phosphorus load is 4,426 lbs/yr. There are no significant point source dischargers of nutrients in the Newport Creek watershed, and thus the total load is due to nonpoint sources. Figure 4b shows the relative contributions of nitrogen and phosphorus from the various sources.

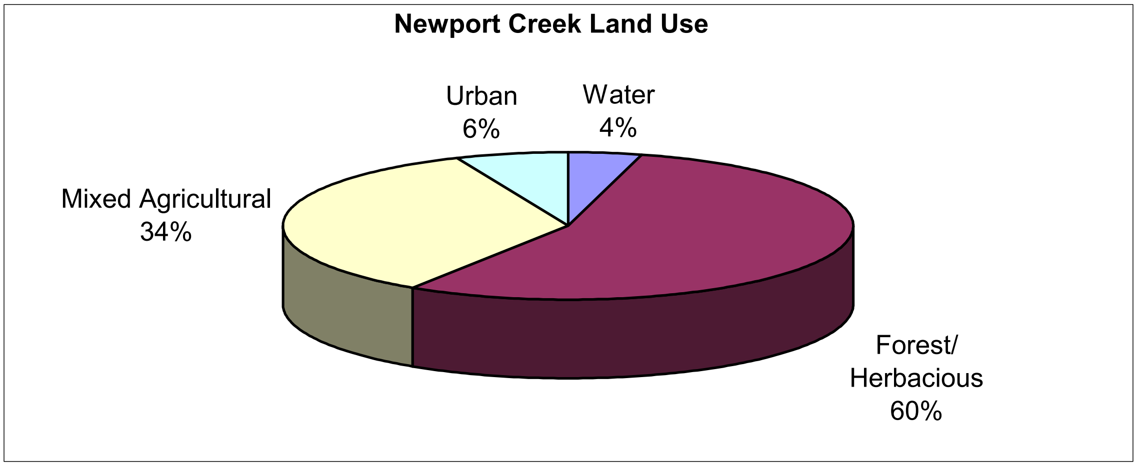


**Figure 3b: Land Use in the Newport Creek Watershed**

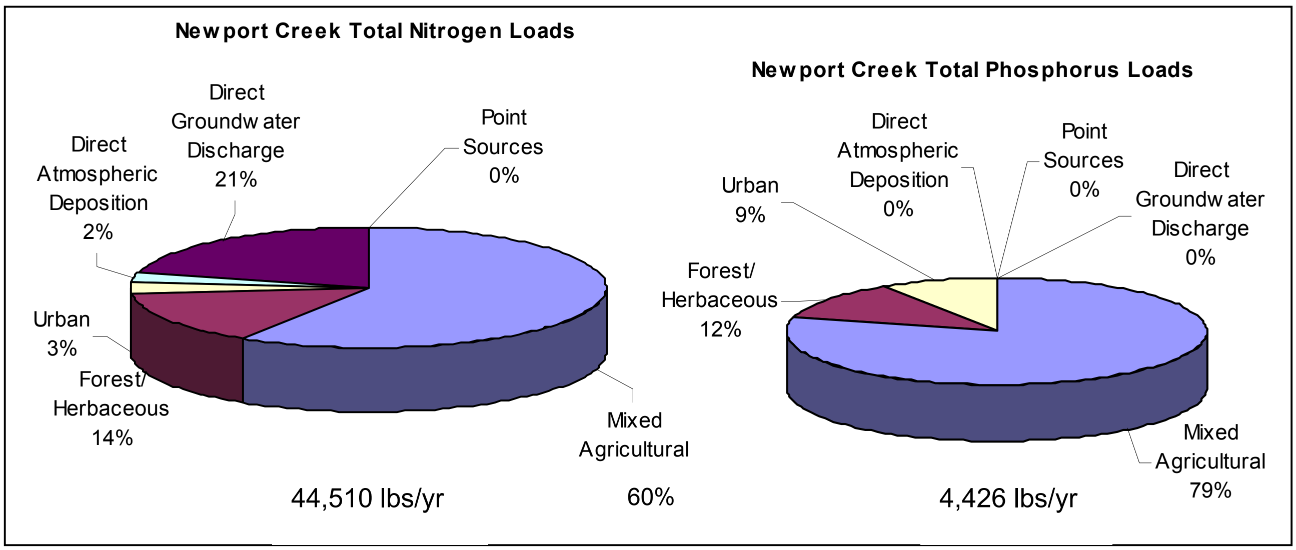


**Figure 4b: Average Annual Total Nitrogen and Total Phosphorus Loads Entering Newport Creek**

### 2.1.3 Newport Bay

Newport Bay has a drainage area of 32,492 acres (131.5 km$^2$), which includes Trappe Creek, Marshall Creek and all the other subwatersheds described above. The average cross-section depth of the bay ranges from 0.5 meter from its head to 1.75m near its mouth. The land use in the Newport Bay watershed consists of forest and other herbaceous (13,554 acres or 42 %), mixed agriculture (10,672 acres or 33 %), and urban (2,987 acres or 9%). The water surface area of Newport Bay is approximately 5,279 acres (21.4 km$^2$ or 16 %). Figure 3c shows the relative amounts of the different land uses in the Newport Bay watershed.

In the Newport Bay watershed, the baseline average annual total nitrogen load is 407,551 lbs/yr. Direct atmospheric deposition to the water's surface accounts for approximately 9% of the load, and direct groundwater discharge accounts for approximately 12% of the load. The baseline average annual nonpoint source total phosphorus load is 32,599 lbs/yr. Figure 4c shows the relative contributions of nitrogen and phosphorus from the various sources.

There are two significant point source discharges of nutrients in the Newport Bay watershed. These sources are the Berlin Wastewater Treatment Plant (WWTP), and Tyson Foods Inc. The Berlin WWTP discharges to Trappe Creek through a tributary called Bottle Branch. Tyson Foods, Inc. discharges to Newport Bay System through Kitts Branch. In addition to producing algal growth downstream of Kitts Branch, Tyson's discharge contributes to a DO sag in Kitts Branch under critical summertime flow conditions. For this reason, a TMDL has been addressed separately for BOD in Kitts Branch.

Several other minor point source discharges exist in the Newport Bay watershed: Kelly Foods Corp.; Newark WWTP; Ocean City Ice and Seafood; and Berlin Shopping Center (which existed during the monitoring period of 1998 but is now closed). The details of the point sources under consideration for modeling purposes have been presented in Appendix A of this report. All of the point sources (majors and minors) contribute a total of about 122,764 lbs/yr of nitrogen and 6,180 lbs/yr of phosphorus to Trappe Creek and eventually to Newport Bay.

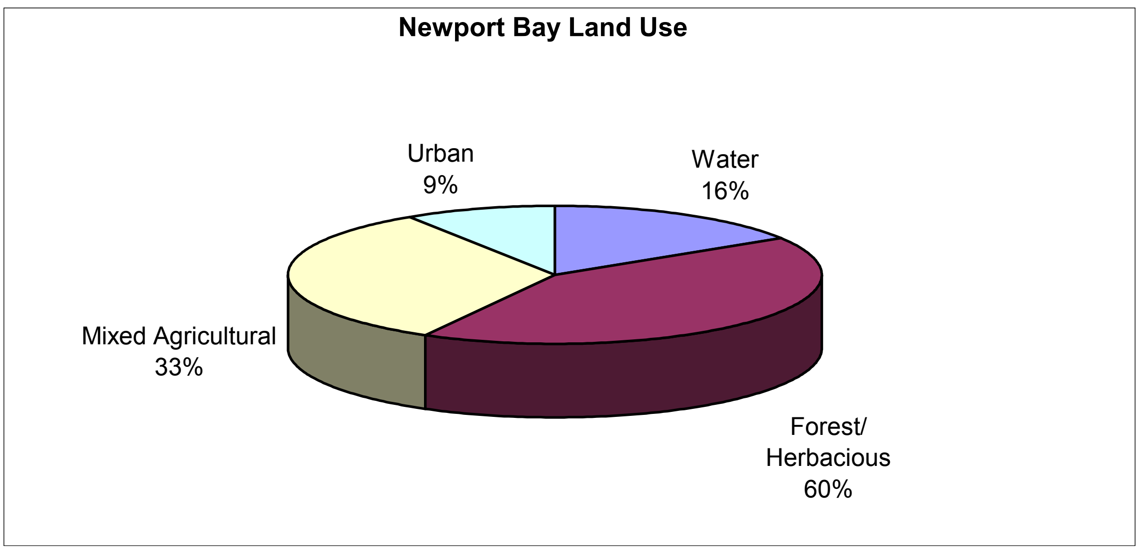


**Figure 3c: Land Use in the Newport Bay Watershed**

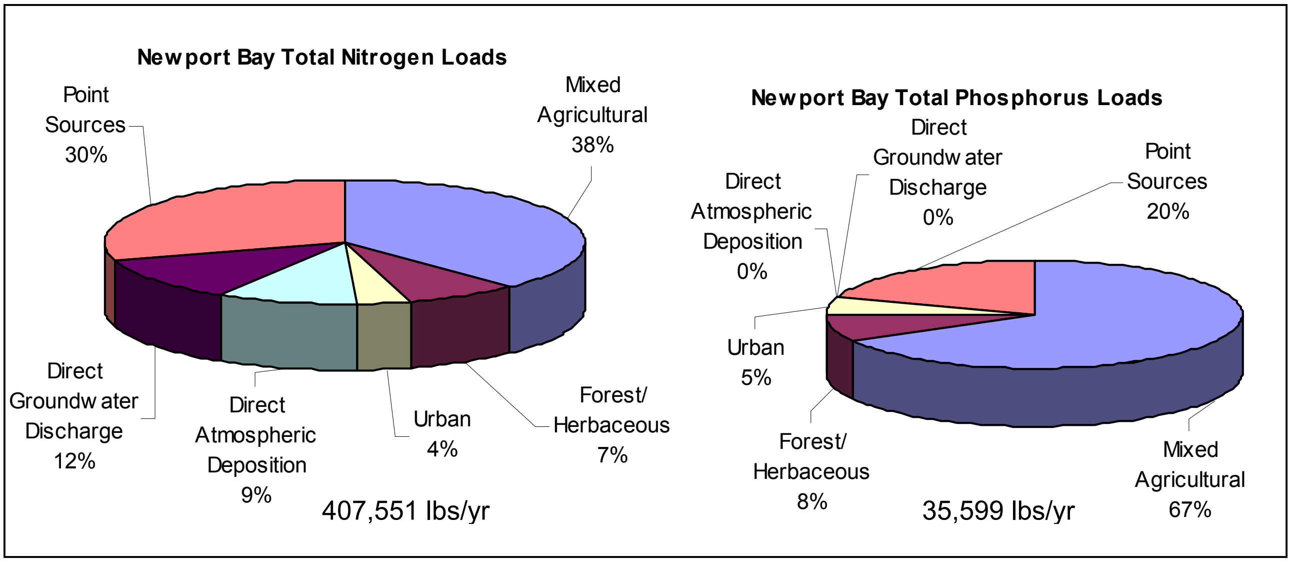


**Figure 4c: Average Annual Total Nitrogen and Total Phosphorus Loads Entering Newport Bay**

*BOD TMDL*

### 2.1.4 Kitts Branch

Kitts Branch is a non-tidal stream that drains from the Town of Berlin and discharges to Newport Bay via Trappe Creek. A number of point sources discharge to Kitts Branch. The point source of primary interest is the Tyson Foods discharge. The other point sources are Kelly Foods and the Berlin Shopping Center, which is now closed (although it was operational during the modeling timeframe). Kitts Branch has a watershed area of approximately 2,710 acres (11 $km^2$). Kitts Branch watershed land use consists of mixed agriculture (1,192 acres or 44%), forest and other herbaceous cover (810 acres or 30 %), and urban (676 acres or 25 %). The water surface area of Kitts Branch is 32 acres (0.13 $km^2$). Figure 3d shows the relative amounts of the different land uses in Kitts Branch watershed. Typical BOD loads under spring and summer flow regimes are 100.3 lbs/day and 27.96 lbs/day, respectively. These loads, based on 1998 observed data, take into account all sources of BOD, including point sources nonpoint sources and atmospheric deposition. The nonpoint source contribution to the spring load is approximately 37.7 lbs/day and loads from point sources account for approximately 62.5 lbs/day. In a similar way, BOD loads contributions during the summer 1998 accounted for 6.4 lbs/day while nonpoint sources contributed 21.5 lbs/day.

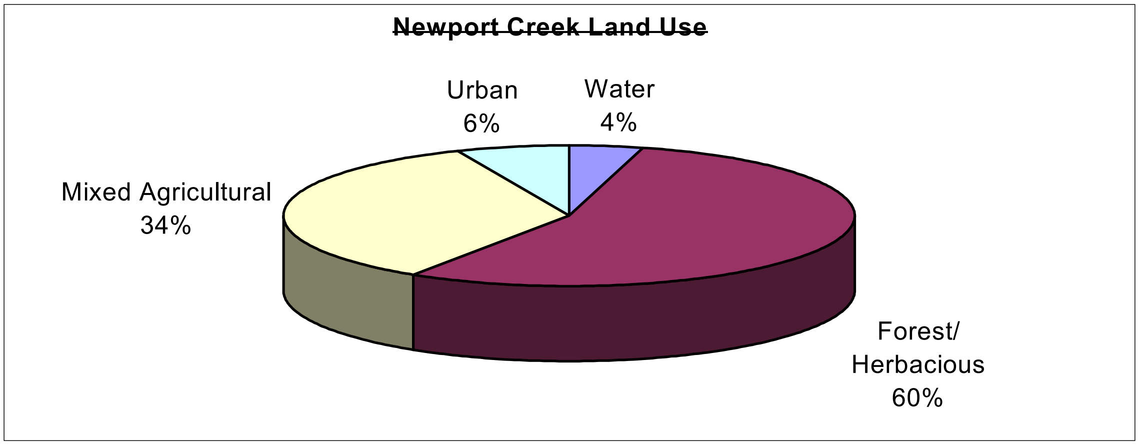


**Figure 3d: Land Use in Kitts Branch**

## 2.2 Water Quality Characterization

Four key water quality parameters associated with eutrophication are presented below: chlorophyll *a*, DO, dissolved inorganic nitrogen (DIN), and dissolved inorganic phosphorus (DIP). Figure 6 through Figure 9 presented below draw upon four data sources: 1998 MDE data, 1998; Department of Natural Resources (DNR) data, 1998; Maryland's Coastal Bays Program (MCBP) volunteer data; and National Park Service data. The reader is referred to Figure 5 for the locations of the water quality sampling stations.

Problems associated with eutrophication are most likely to occur during the low flow period (July - October). During this season there is typically less stream flow available to flush the system, more sunlight to grow aquatic plants, and warmer water temperatures, which are favorable conditions for biological processes of both plant growth and decay of dead plant matter. The period of moderately warm months (April - May and October) is also favorable for producing excessive algal growth. Because problems associated with eutrophication are usually most acute during these seasons, the temperature, flow, sunlight, and other parameters associated with these periods represent critical conditions for the TMDL analysis for low flow and high flow conditions. Figure 6 through Figure 9 present data from the low and moderately warm high flow periods.

Figure 6 presents ambient chlorophyll *a* data for low flow conditions (July – October) and high flow conditions (April). The figure shows that the chlorophyll *a* concentrations in the summer for the open bays typically range between 5 – 50 µg/l. In Trappe Creek, concentrations begin to increase upstream to near 125 µg/l with a maximum value of 200 µg/l. The levels are also higher in two tidal tributaries, Ayer Creek and Newport Creek. In Ayer Creek, the maximum chlorophyll *a* value observed was about 140 µg/l. In Newport Creek a maximum chlorophyll *a* value of 80 µg/l was observed. During the high flow months (April data), a maximum chlorophyll *a* value of 125 µg/l was observed in Trappe Creek. Data from Ayer Creek reveal some levels greater than 50 µg/l.

Figure 7 presents surface water DO data for low flow conditions (July – October) and high flow conditions (April). The data show the DO levels are below the standards throughout the basin during low flow months. The DO levels in the Ayer Creek have been observed below 2.5 mg/l. The Kitts Branch data also show low levels of DO warranting a TMDL for BOD. DO levels in Newport Creek have been seen frequently going below the criterion of 5.0 mg/l. During the high flow months, with the current conditions of flow and concentration, the DO levels are always shown above the criterion of 5.0 mg/l.

Figure 8 presents the DIN levels measured in the samples collected during low flow and high flow conditions. Concentrations in the open bays and lower portions of Trappe Creek are very low with slightly higher concentrations around 0.2 mg/l in the middle of Trappe Creek. The data for the upper portion of Trappe Creek shows higher levels of DIN reaching 4 mg/l. The Kitts Branch data shows the level of DIN reaching higher than 7 mg/l. The Ayer Creek data shows a maximum level of 1 mg/l while in Newport Creek the levels are below 0.5 mg/l. A similar pattern is also observed during the high flow season with a level of DIN exceeding 8 mg/l in Kitts Branch. Although, nitrates do not impair Kitts Branch itself, they are a source contributing to downstream problems and thus are limited as part of the Newport Bay mainstem TMDL.

Figure 9 presents the DIP as indicated by ortho-phosphate levels measured in samples collected during low flow and high flow conditions. As shown in Figure 9, the highest DIP values are in Trappe Creek and Kitts Branch reaching to a level of 0.4 mg/l. The levels in the rest of the system are below 0.05 mg/l. A similar pattern is observed during the high flow period in the entire system.

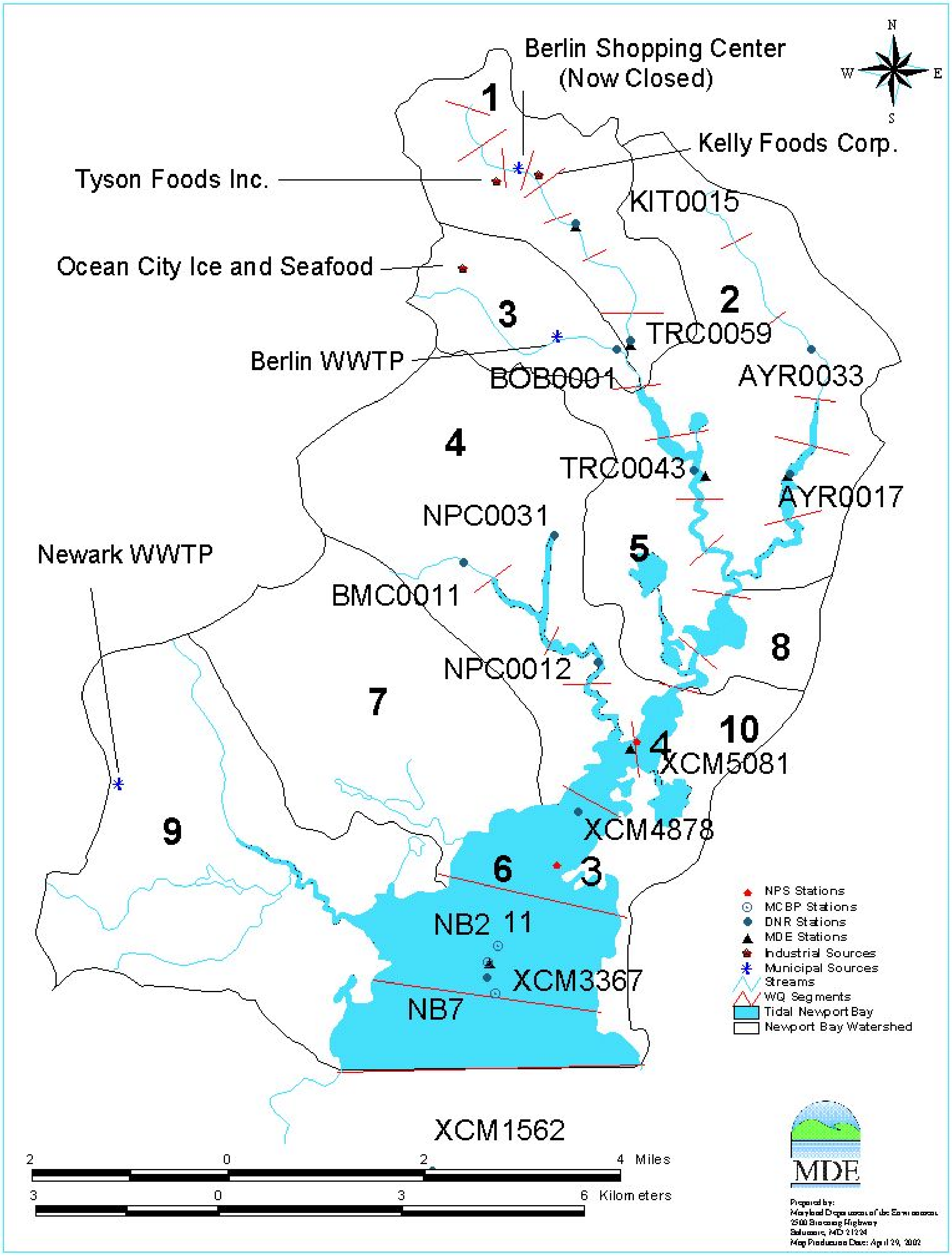


**Figure 5: Location Map of the Newport Bay Water Quality Stations**

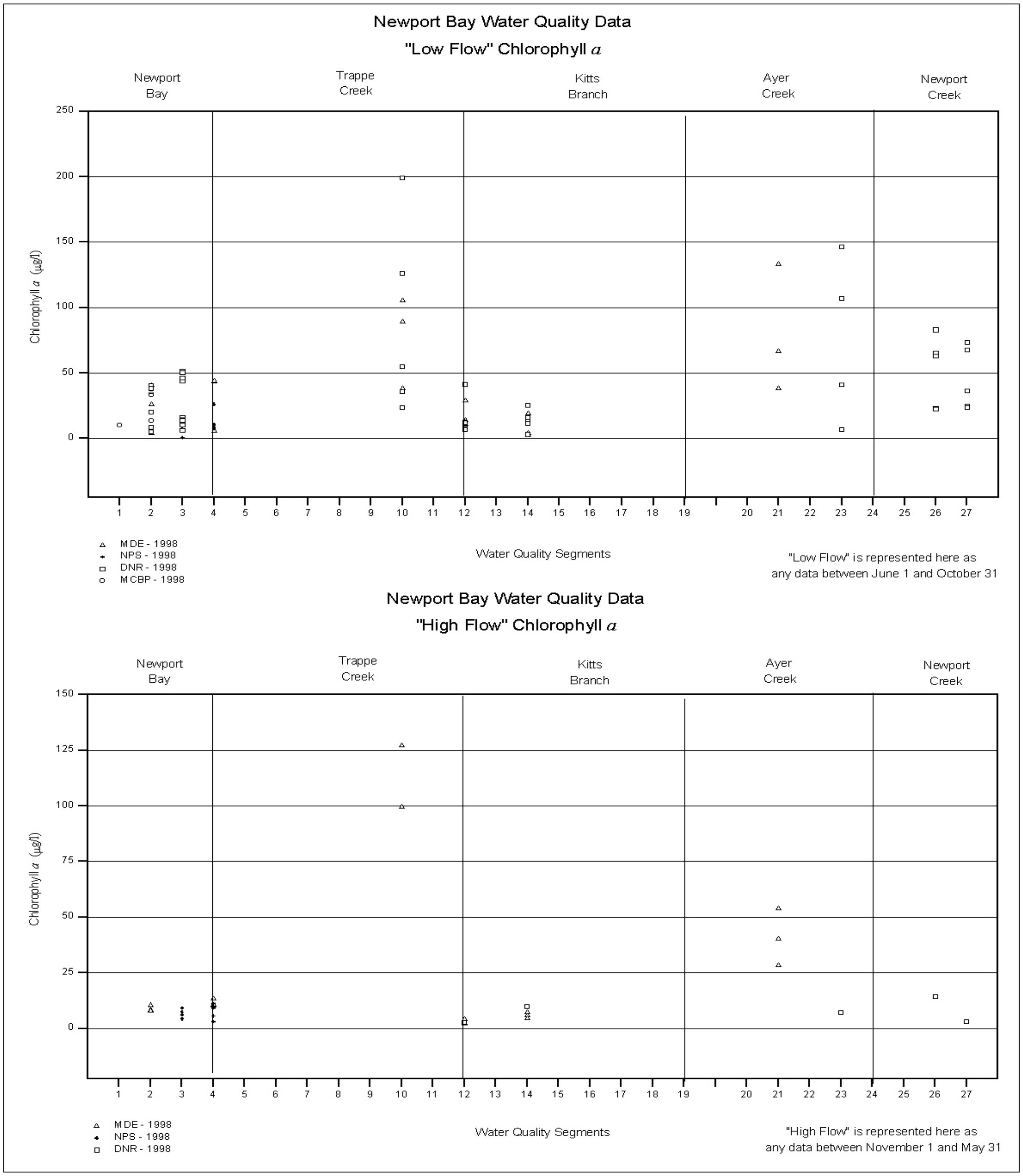


**Figure 6: Chlorophyll *a* data for all stations in Newport Bay During Low and High Flow Conditions**

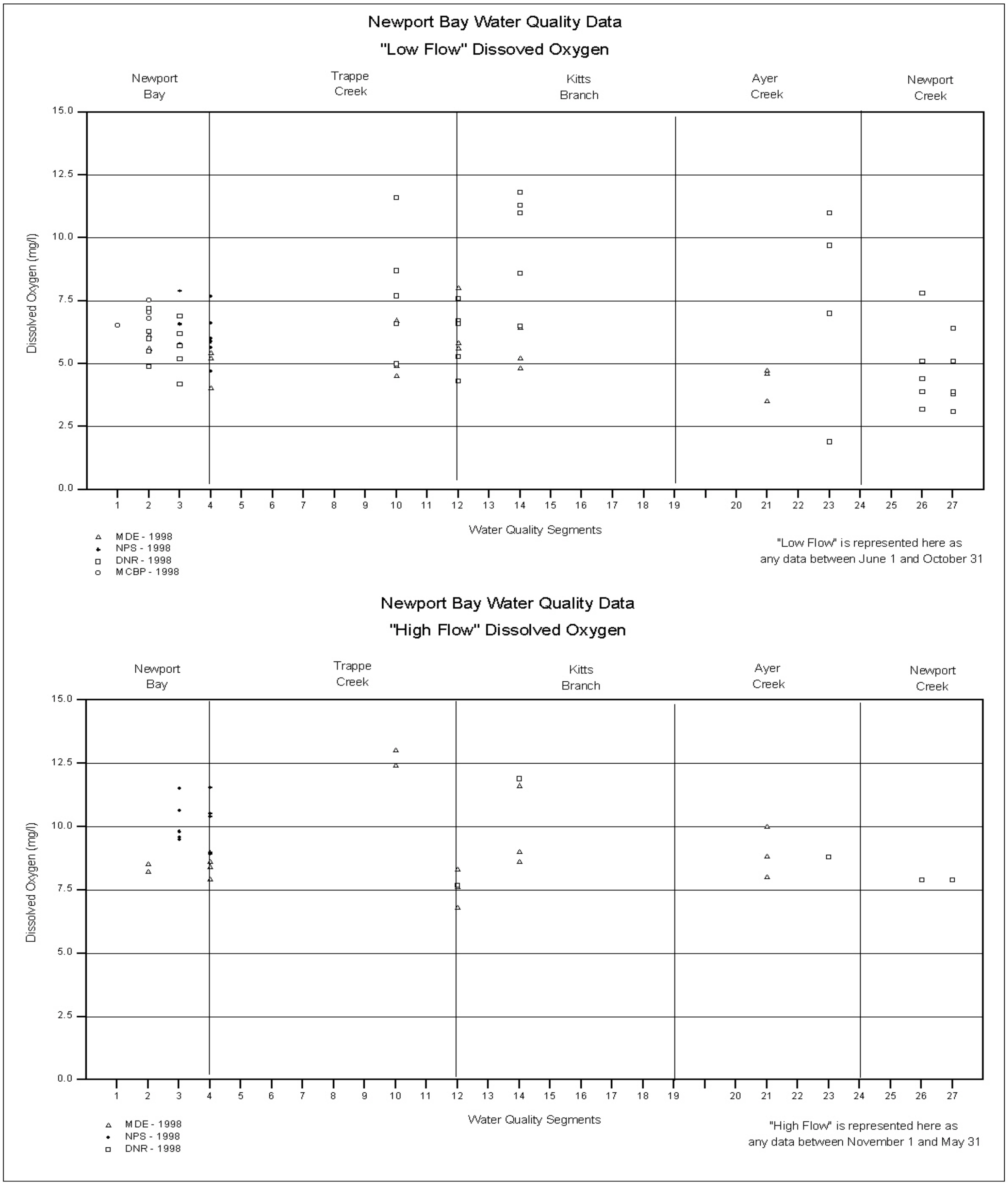


**Figure 7: Dissolved Oxygen data for all stations in Newport Bay during Low and High Flow Conditions**

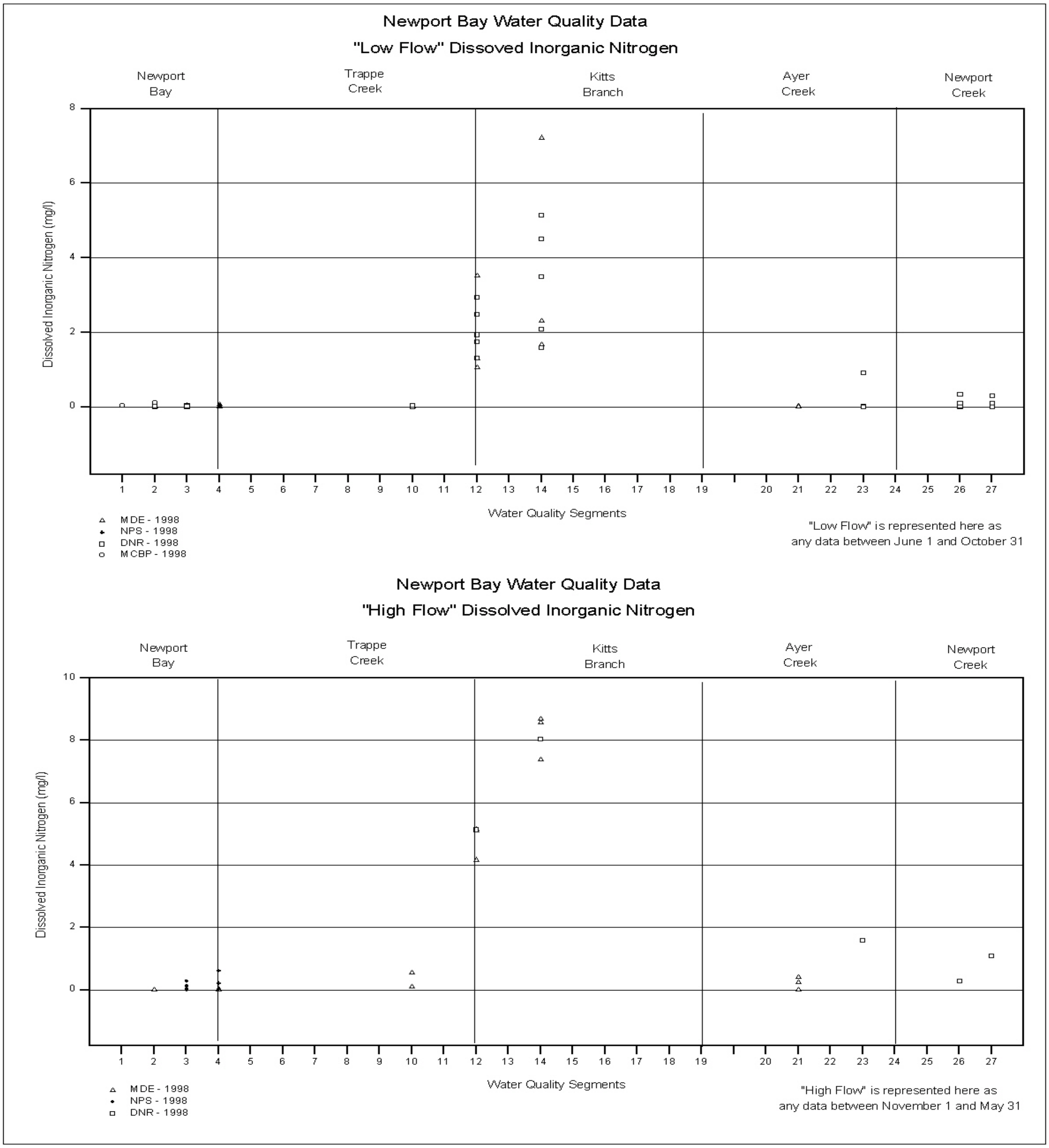


**Figure 8: Dissolved Inorganic Nitrogen data for all stations in Newport Bay during Low and High Flow Conditions**

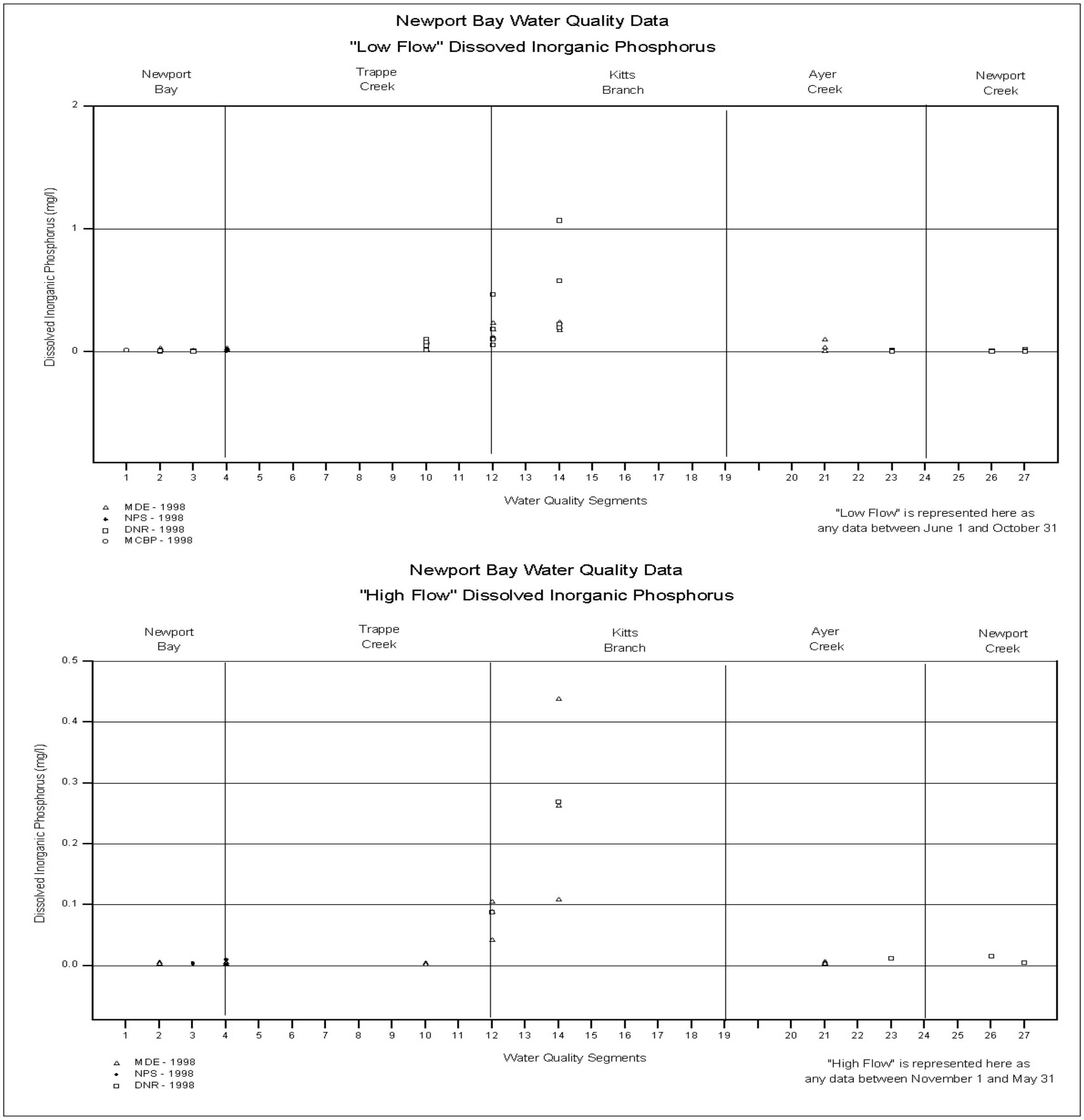


**Figure 9: Dissolved Inorganic Phosphorus data for all stations in Newport Bay during Low and High Flow Conditions**

### 2.3 Water Quality Impairment

The Maryland water quality standards Surface Water Use Designation for all estuarine portions and tributaries of the Newport Bay, is Use II - *Shellfish Harvesting Waters*. Designated Use II waters are protected for shellfish harvesting (oysters, softshell clams, hardshell clams, and brackish water clams), where there are actual or potential areas for shellfish propagation, storage, and gathering for market purposes. The complete details of Use II and all other water uses can be found in the *Code of Maryland Regulations* (COMAR), Section 26.08.02.

The water quality impairments in the Newport Bay system being addressed by these TMDLs apply to Use II waters. They consist of violations of the numeric criterion for DO, and elevated chlorophyll *a* levels, an indicator of excessive eutrophication. The substances causing these water quality impairments are nitrogen (in Ayer Creek, Newport Creek, and Newport Bay) and BOD (in Kitts Branch).

According to the applicable numeric criterion for DO, concentrations may not be less than 5.0 mg/l at any time (COMAR 26.08.02.03-3A(2)) unless resulting from natural conditions (COMAR 26.08.02.03.A(2)). The applicable narrative water quality criteria pertaining to excessive eutrophication for the designated uses in Newport Bay are set forth in COMAR 26.08.02.03 and 26.08.02.02B. (See Section 3.0.)

*Nitrogen TMDLs*

<u>Ayer Creek</u>: The chlorophyll *a* concentrations in the Ayer Creek ranges between 5 and 140µg/l during summer months with higher values occurring in poorly flushed areas (See Figure 6). The DO along the same areas also often falls below the criterion of 5.0 mg/l (See Figure 7). During spring, the warmer flow month; Ayer Creek still shows some sign of eutrophication (higher than a desired goal). In summary, high chlorophyll *a* and low DO data indicate an impairment, which justifies a TMDL analysis.

<u>Newport Creek:</u> The chlorophyll *a* concentrations observed in Newport Creek, during the low flow period range between 20 and 80 µg/l. The data was collected by the volunteer monitoring program of the Maryland Coastal Bays Program. The DO level consistently falls below the standard of 5.0 mg/l. In summary, high chlorophyll *a* and low DO data indicate an impairment, which justifies a TMDL analysis.

<u>Newport Bay</u>: The entire tidal Newport bay as indicated by the data is impaired with signs of eutrophication and low DO. The upper tidal portion of the bay lying on Trappe Creek shows the chlorophyll *a* level frequently exceeding 100 µg/l (typical range from 5 – 125 µg/l, with occasional values above 150 µg/l). The DO concentration is often below the standard of 5.0 mg/l throughout the Newport Bay region (See Figure 7). During the spring months, Newport Bay shows signs of eutrophication (the chlorophyll a reaches to 125 µg/l). In summary, high chlorophyll *a* and low DO data indicate an impairment, thereby justifying a TMDL analysis.

*BOD TMDL*

<u>Kitts Branch:</u> Most of Kitts Branch is a free flowing zone except a little portion of it lies on a tidally influenced area. The chlorophyll *a* values in this stream range between 3 and 25 µg/l (well below the desired goal) showing the stream is not much influenced by eutrophication; however there is an occasional drop of DO below the standard of 5 mg/l (see Figure 7). In addition, the model shows the DO level in Kitts Branch is sensitive to the BOD discharge from the major point source, Tyson Foods, Inc. In summary, the DO data and model indicate a TMDL analysis for BOD is warranted.

## 3.0 TARGETED WATER QUALITY GOAL

*Nitrogen TMDLs*

The overall objective of the nitrogen TMDLs established in this document is to reduce nitrogen loads to levels that are expected to meet water quality criteria associated with eutrophication that support the Use II designation and to reduce BOD in Kitts Branch to achieve the same goal. Specifically, reduction in the nitrogen load is intended to control excessive algal growth. Excessive algal growth can lead to violations of the numeric DO criteria, associated fish kills, and the violation of various narrative criteria associated with nuisances, such as odors, and impedance of direct contact use and the loss of habitat for the growth and propagation of aquatic life and wildlife.

In summary, the TMDLs for nitrogen are intended to:

1. Assure that a minimum DO concentration of 5.0 mg/l is maintained throughout Newport Bay; and

2. Resolve violations of narrative criteria associated with excess nutrient enrichment of Newport Bay, as reflected in chlorophyll *a* levels greater than 50 µg/l in the poorly flushed tidal embayments.

The chlorophyll *a* level is based on the designated uses of Newport Bay, guidelines set forth by Thomann and Mueller (1987) and by the EPA Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (1997).

*BOD TMDL*

A BOD TMDL is proposed in Kitts Branch, due to occasional violations of DO and sensitivity of this small creek to point source discharges. A BOD cap load is proposed in this small freshwater tributary of the Newport Bay system to assure the DO level stays above the standard of 5.0 mg/l at all times.

# 4.0 TOTAL MAXIMUM DAILY LOADS AND ALLOCATION

## 4.1 Overview

This section describes how the TMDLs and load allocations were developed for the Newport Bay system. The first section describes the modeling framework for simulating nutrient loads, hydrology, and water quality responses. The second and third sections summarize the scenarios that were explored using the model. The assessment investigates water quality responses assuming different stream flow and nutrient loading conditions. The fourth and fifth sections present the modeling results in terms of TMDLs and possible load allocations. The sixth section explains the rationale for the margin of safety (MOS). Finally, the pieces of the equation are combined in a summary accounting of the TMDLs for seasonal summer flow, spring flow, and winter flow load conditions.

## 4.2 Analysis Framework

The computational framework chosen for all four Newport Bay TMDLs was the Water Quality Analysis Simulation Program Version 5.1 (WASP5.1). This water quality simulation program provides a generalized framework for modeling contaminant fate and transport in surface waters and is based on the finite-segment approach (Di Toro *et al.*, 1983). WASP5.1 is supported and distributed by U.S. EPA's Center for Exposure Assessment Modeling (CEAM) in Athens, GA (Ambrose *et al.*, 1993). EUTRO5.1 is the component of WASP5.1 that simulates eutrophication, incorporating eight water quality constituents in the water column and the sediment bed.

The WASP5.1 model was implemented in a steady-state mode. This mode of using WASP5.1 simulates constant flow, and average water body volume over the tidal cycle. The tidal mixing is accounted for using dispersion coefficients, quantifying the exchange of water quality constituents between WASP5.1 model segments. The model simulates an equilibrium state of the waterbody, which in this case, was calibrated to low flow (summer/fall) and high flow (spring/winter) conditions, and applied to summer low flow, spring flow and winter flow conditions, described in more detail below.

The spatial domain of the Newport Bay Eutrophication Model (NBEM) includes the Newport Bay, Kitts Branch, Trappe Creek, Ayer Creek, and Newport Creek. It extends from the confluence of Sinepuxent Bay to the upper reaches of Kitts Branch covering all the point sources of concern in the Newport Bay system. The modeling domain is represented by 27 model segments. A diagram of the WASP5.1 model segmentation is presented in Appendix A.

For the Newport Bay system, the water quality model was calibrated to reproduce observed water quality characteristics for both conditions observed in 1998 for low flow and high flow periods. The calibration of the model for these two flow regimes establishes an analysis tool that may be used to assess a range of scenarios for differing flow and nutrient loading conditions. Temporal and spatial data availability as well as temperature and flow measurements were examined to determine the appropriate data to include in each calibration. The low flow calibration uses data from July 1998 to September 1998, and the high flow calibration uses data from April 1998. More information can be found in Appendix A.

The estimation of stream flow used for the calibration of the model was based on an area-flow ratio calculated using 1998 flow data from the United States Geological Survey (USGS) stream gaging station 01485000 in the Pocomoke River near Willards. No active USGS gaging station was in operation in the Newport Bay basin during the 1998 analysis period. The Pocomoke gage data was considered a reasonable estimate of the flow in the Newport Bay system due to its similar geology, topography, and proximity to the area. A comparative study was performed to verify that the flow used from Pocomoke USGS station applies well to the flow calculation in Newport Bay. This analysis was performed using flow data from a USGS station recently established in Birch Branch in the Northern Coastal Bay System. More detailed information on stream flow estimation can be found in Appendix A.

There are six point sources in the Newport Bay system: Berlin WWTP; Newark WWTP; Kelly Foods Corporation; Tyson Foods, Inc.; Ocean City Ice and Seafood; and Berlin Shopping Center. All point sources were considered in the development of the model; however, only two of the six sources (Berlin WWTP and Tyson Foods, Inc.) have been emphasized in the development of the TMDLs. The smaller point sources have an insignificant effect on water quality. Annually, the six point sources contribute about 122,764 lbs/yr of nitrogen and 6,180 lbs/yr of phosphorus to the Newport Bay system.

To determine the loads for the point sources, 1998 point source discharge data from the MDE point source database was used (MDE, 2002). Additional data from Tyson Foods, Inc. (provided by John Lister) and MDE's Eastern Shore Field Office (provided by Randy Danny) were used as supplements. See Appendix A for details.

The method for estimating NPS loadings of nitrogen and phosphorus is described in Section 4.3. In brief, low flow and high flow NPS loads used during the model calibration process were derived from concentrations observed during low and high flow sampling in 1998 multiplied by the estimated corresponding flows. Because the loading estimations are based on observed data, which incorporate all sources, they account for all human and natural sources.

The NPS loads for the low flow baseline conditions were derived using observed data in the same manner as were done for the calibration process for low flow conditions. The average annual NPS loads were based on unit area loading rates for general land use categories derived in a study conducted in the Maryland Coastal Bays (University of Maryland, 1993). The land use information, to which the unit area loading rates were applied, was based on 1997 Maryland Office of Planning land cover data, and 1997 Farm Service Agency data. These methods are elaborated upon in Section 4.3 and in Appendix A.

It is important to note that the estimated NPS loads for baseline conditions (for winter and spring flows) serve solely as a rough basis by which to compare the NPS reduction needed to reach the TMDL limits. The analysis used to estimate the maximum allowable load to the water body (TMDL) does not depend on the baseline estimate of NPS loads. Thus, any uncertainty in the baseline NPS estimation does not affect the certainty of these estimated TMDLs.

The nitrogen TMDL analyses consist of an assessment of low flow, and assessments of high flow (spring and winter) loading conditions for the entire Newport Bay System. The low flow TMDL analysis investigates the critical conditions under which symptoms of eutrophication are typically most acute. This occurs in late summer when flows are low, leading to poor flushing of the system, and when sunlight and temperatures are most conducive to excessive algal production. The high flow TMDL analysis helps control immediate water quality impacts and long term effects of nutrients that may be transported and accumulate in the bottom sediments and recycled into the system during warmer periods.

### 4.3 Scenario Descriptions

The WASP5.1 model was applied to investigate different nutrient loading scenarios. Due to the nature of the Newport Bay system and changes in the point source operations during different seasons, the scenarios were grouped into three flow regimes: summer flow condition; spring flow condition; and winter flow condition. Two scenarios (baseline conditions, and future conditions associated with TMDLs) were investigated for each flow regime, yielding a total of six scenarios.

The baseline condition scenarios are intended to provide a point of reference to compare with the future condition scenarios that simulate conditions of a TMDL. Defining this baseline for comparison with the TMDL outcome is preferred to trying to establish a “current condition”. The baseline is defined in a consistent way among different TMDL projects and does not vary in time. The alternative of using a “current condition” has the drawback of changing over time, thereby creating confusion. Since the development and review of a TMDL often takes years, the “current” condition is no longer current by the time the TMDL is complete. To avoid this confusion, we use the “baseline condition”. The baseline conditions correspond roughly to the notion of "worst-case conditions" for the given flow regime. For the given flow conditions, the scenarios reflect an approximation of present NPS conditions, and maximum point source flows with estimated concentrations assuming no additional treatment beyond which is currently planned.

A separate analysis indicated that algal growth is limited by nitrogen. As such, this TMDL analysis is limited to limits on nitrogen. The reader is referred to Appendix B for more information.

The modeling analyses focused on the Ayer Creek, Kitts Branch, Newport Creek, and Newport Bay. These results provide an explicit basis for the TMDLs in these areas.

<u>First Scenario</u>: (Low Flow Baseline) The first scenario simulates the baseline condition critical low stream flow in the basin, i.e., the summer flow condition. The scenario simulates a critical condition when the river system is poorly flushed, and sunlight and warm water temperatures are most conducive to creating the water quality problems associated with excessive nutrient enrichment.

The low flow NPS loads were computed as the product of the observed concentrations and estimated critical low flow. The method of estimating the critical low flow is described in Appendix A. The nutrient concentrations from which NPS loads were computed were based on observed data collected during low flow conditions in July, August and September of 1998 (MDE, DNR, MCBP). These low flow NPS loads integrate all natural and human induced sources that contribute to base flow during low flow conditions. For the open waters of the bay, additional load was added to account for direct atmospheric deposition to the water surface. (See Appendix A for further discussion).

The significant point source loads were determined on the basis of 1998 plant monitoring records for the significant point sources. Because the Berlin WWTP uses land application of waste, it does not discharge to surface waters during summer/spring flow months from April through October. Tyson Foods' flow was increased to planned values with current or anticipated point source treatment technologies. Additional technical details are provided in Appendix A.

Second Scenario: (Spring Flow Baseline) The second scenario provides an estimate of water quality conditions for spring (April and May) condition flows and loads, which serves as the baseline by which to compare the spring flow TMDL (Fifth Scenario). The second scenario simulates a condition when the sunlight and warm water temperatures are most conducive to algal growth, which can lead to water quality problems associated with excessive nutrient enrichment. The assumptions of high water temperature and solar radiation used in the analysis are conservative with respect to environmental protection.

The spring NPS loads were based on land use loading rates derived in a study conducted in the Maryland Coastal Bays (University of Maryland, 1993). The land use information was based on 1997 Maryland Office of Planning land cover data and 1997 Farm Service Agency data. The land use loading rates (lbs/acre) were multiplied by the acreage of each corresponding land use to estimate surface water loads. Additional loads were added to account for direct atmospheric deposition to the water's surface, and direct groundwater discharge to the tidal waters. These methods are elaborated upon in Appendix A.

The point source flows for the significant point sources remained same as in Scenario 1. The concentrations were changed to reflect the current plant operating conditions outside of the low flow permit period (typically May – October). Again the Berlin WWTP is not considered in this scenario because the plant does not discharge to surface waters during this flow regime period.

Third Scenario: (Winter Flow Baseline) The third scenario presents an estimate of baseline water quality conditions for winter flow conditions and moderate temperature conditions. A water temperature based on long term data for the end of March was used. This choice is discussed further in Appendix A. This scenario thus simulates a maximum loading condition in the basin with respect to both point sources and nonpoint sources. This scenario helps to reduce excessive nutrients in the Newport Bay System, which in turn would affect nutrient flux releases during warmer seasons. Also, this would help to protect the downstream basin of the Newport Bay by cutting down excessive nutrient inputs to it. The NPS loads were estimated as described in Scenario 2. The point source loads for all sources, except Berlin WWTP, remained the same as in Scenario 2. During this flow regime, Berlin WWTP discharge was introduced at a flow of 1.0 million gallons per day (MGD) with the current nutrient load.

Fourth Scenario: (Low Flow Future Condition, TMDL) The fourth scenario represents the future condition of maximum allowable nitrogen and BOD loads during the summer flow regime. The stream flow is the same as that used in the first scenario. The scenario simulates a condition when the system is poorly flushed due to low flows, sunlight and warm water temperatures are most conducive to algal growth. These conditions are critical for causing water quality problems associated with excessive nutrient enrichment, and BOD effects.

For the Newport Bay system, this scenario simulates an estimated 45% reduction in total surface water nonpoint source nitrogen loads in all TMDL basins (Ayer Creek, Newport Creek, and Newport Bay). A 20% reduction in the direct atmospheric deposition of nitrogen loads to the water's surface throughout the Newport Bay is included to account for implementation of the Clean Air Act. This scenario accounts for an explicit MOS computed as 5% of the NPS load allocation in the entire Newport Bay System.

The Tyson Foods point source load was reduced from the baseline load in Scenario 1. A nitrogen limit of 4 mg/l was proposed for Tyson Foods to achieve the desired goal. The Berlin WWTP does not discharge to the surface waters during the low flow period. The loads for all other negligible sources were kept at the same levels as Scenario 1. The details of the point sources loads are further described in Appendix A, and in the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*." In this future condition scenario, reductions in sediment nutrient fluxes and SOD were estimated based on changes in the nutrient loads to the system. Further discussion is provided in Appendix A.

Fifth Scenario: (Spring Flow Future Condition, TMDL) The fifth scenario represents the future condition of maximum allowable loads during the spring flow regime. The stream flow is the same as that used in the second scenario. This scenario simulates a condition when the sunlight and warm water temperatures are most conducive to algal growth, which can lead to water quality problems associated with excessive nutrient enrichment. These conditions are conservative for this flow regime.

A NPS nitrogen load reduction of 45% was simulated throughout the basin. In addition, direct atmospheric deposition loads of nitrogen to the water's surface was reduced by 20% to account for the implementation of the Clean Air Act. This scenario accounts for an explicit MOS computed as 5% of the NPS nitrogen load allocation in all the tributaries.

All the point source loads except Tyson Foods remained the same as for Scenario 2. Tyson Foods' nitrogen load was restricted to a concentration of 8 mg/l. The details of the point source loads are described further in Appendix A, and the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*." In this future condition scenario, reductions in sediment nutrient fluxes and SOD were estimated based on changes in the nutrient loads to the system. Further discussion is provided in Appendix A.

Sixth Scenario: (Winter Flow Future Condition, TMDL) The sixth scenario represents the future condition of maximum allowable loads during the winter flow regime. The stream flow, water temperatures and solar radiation are the same as that used in the third scenario.

A nonpoint source nitrogen load reduction of 45% was simulated throughout the basin. Although this amount of reduction is not necessary to meet standards in the winter, it is included to be consistent with necessary reductions for the spring and summer season. In addition, direct atmospheric deposition loads of nitrogen to the water's surface was reduced by 20% to account for the implementation of the Clean Air Act. This scenario accounts for an explicit MOS computed as 5% of the NPS nitrogen load allocation in all the tributaries.

All the point source loads except Tyson Foods and Berlin WWTP remained the same as for Scenario 3. Tyson Foods' nitrogen load was restricted for a concentration of 18 mg/l. The Berlin WWTP nitrogen load was restricted to a concentration of 24 mg/l. The details of the point source loads are described further in Appendix A, and the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*." In this future condition scenario, reductions in sediment nutrient fluxes and SOD were estimated based on changes in the nutrient loads to the system. Further discussion is provided in Appendix A.

### 4.4 Scenario Results

This section presents the results of the model scenarios described in the previous section. The analysis ensures that the DO criterion of 5.0 mg/l is maintained at all times.

The NBEM results for DO presented in this section are daily average concentrations. The analysis recognized the effects of diurnal DO fluctuations due to over-night respiration of aquatic plants that causes a depletion of DO. To account for this, the water quality endpoint for the analysis of DO was set as a function of chlorophyll *a* concentration. In Trappe Creek, Ayer Creek and Newport Creek, where chlorophyll *a* levels can be as high as 50 µg/l at the TMDL threshold, the water quality endpoint for comparison with the simulated daily average DO is 6.0 mg/l. That is, a factor of 1.0 mg/l is added to the water quality criterion of 5.0 mg/l to account for the diurnal fluctuation in DO levels. At all other places, where the average chlorophyll *a* is 25 µg/l or less, a target value of 5.3 mg/l DO is used. Further details are presented in Appendix A.

Baseline Loading Condition Scenarios:

1. *Summer Flow:* Simulates critical low stream flow conditions during the summer season. Water quality parameters (e.g., nutrient and BOD concentrations), which serve as NPS loads at the model boundaries, are based on 1998 observed data. In addition, direct groundwater and atmospheric NPS loads are included. Point source contributions represent maximum design flows (or approved sewer flows) and estimated concentrations at those flows. Berlin WWTP does not discharge to surface waters at this time.

2. *Spring Flow:* Simulates spring flow conditions (April & May). Nonpoint source water quality parameters (e.g., nutrient concentrations) are based on University of Maryland Center for Environmental Science (UMCES) land use loading rates. In addition, direct groundwater and atmospheric deposition NPS loads are included. Point source contributions represent maximum design flows (or approved sewer flows) and estimated concentrations at those flows. Berlin WWTP does not discharge to surface waters at this time.

3. *Winter Flow:* Simulates winter stream flow conditions. Nonpoint source water quality parameters (e.g., nutrient concentrations) are based on UMCES land use loading rates. In addition, direct groundwater and atmospheric NPS loads are included. Point source contributions represent maximum design flows (or approved sewer flows) and estimated concentrations at those flows.

Scenario 1 Results: DO and chlorophyll *a* results for the first scenario, representing the baseline condition for summer flow, are summarized in Figure 10. In order to account for diurnal fluctuations, the DO goals, set as a function of expected chlorophyll *a* concentrations under TMDL scenario conditions, are 6.0 mg/l for the levels where the chlorophyll a concentration averages above 50 µg/l, and 5.3 mg/l where the chlorophyll a levels average below 25 µg/l.

Under these conditions, Ayer Creek, Trappe Creek in Newport Bay, and Newport Creek, the desired chlorophyll *a* level is well above the goal of 50 µg/l. In Trappe Creek the value reaches a peak of 110 µg/l. In Ayer Creek, the level reaches a peak of 75 µg/l, whereas in Newport Creek, the level is around 60 µg/l. DO levels throughout the Newport Bay system are below the desired goal of 6.0 mg/l. In Newport Creek the level drops down to 2.5 mg/l. These results indicate that DO concentrations are predicted to fall below the minimum water quality criterion of 5.0 mg/l throughout the modeling domain.

Scenario 2 Results: DO and chlorophyll *a* results for the second scenario, representing the baseline condition for spring flow, are summarized in Figure 11. As previously indicated, in order to account for diurnal fluctuations, the DO goals, set as a function of expected chlorophyll *a* concentrations under TMDL scenario conditions, are 6.0 mg/l for the levels where the chlorophyll *a* concentration averages above 50 µg/l, and 5.3 mg/l where the chlorophyll *a* levels average below 25 µg/l.

Figure 11 shows results for the entire Newport Bay system for spring flow conditions. They indicate the peak chlorophyll *a* level is above the desired goal of 50 µg/l in Ayer Creek, Newport Creek and Trappe Creek in Newport Bay. DO concentrations throughout the Newport Bay system are predicted to be below the analysis goal of 6.0 mg/l as described above.

Scenario 3 Results: DO and chlorophyll *a* results for the third scenario, representing the baseline condition for winter flow, are summarized in Figure 12. As previously indicated, in order to account for diurnal fluctuations, the DO goals, set as a function of expected chlorophyll *a* concentrations under TMDL scenario conditions, are 6.0 mg/l for the levels where the chlorophyll a concentration averages above 50 µg/l, and 5.3 mg/l where the chlorophyll *a* levels average below 25 µg/l.

Figure 12 shows results for the entire Newport Bay system for winter flow conditions. They indicate that the peak chlorophyll *a* level is slightly above the desired goal of 50 µg/l in Trappe Creek (60 µg/l). DO concentrations are predicted to be well above the goal of 6.0 mg/l everywhere in the system.

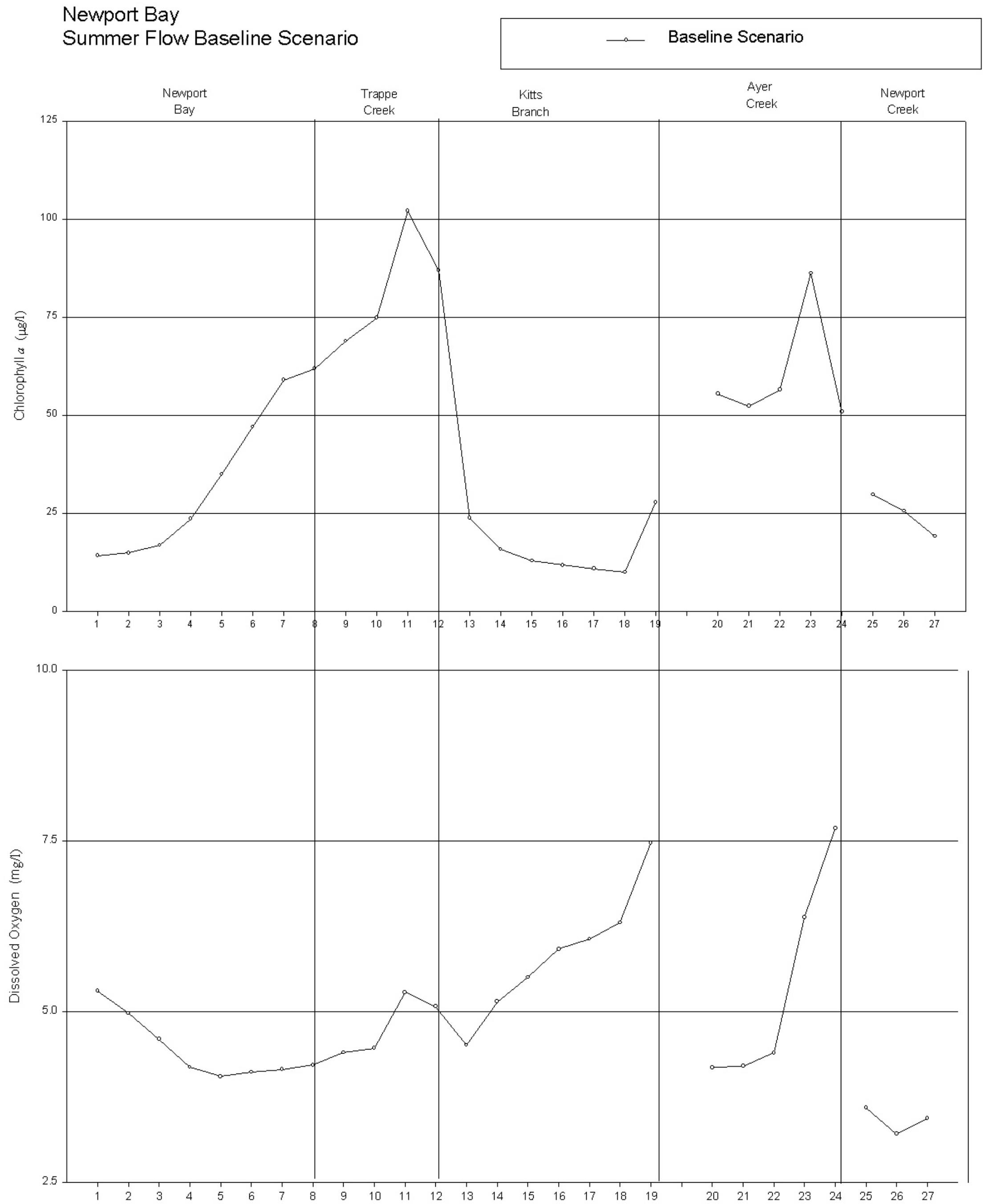


**Figure 10: Model Results for the Summer Flow Baseline Loading Condition Scenario for Chlorophyll *a* and Dissolved Oxygen at Sampling Stations 1 – 27 (Scenario 1)**

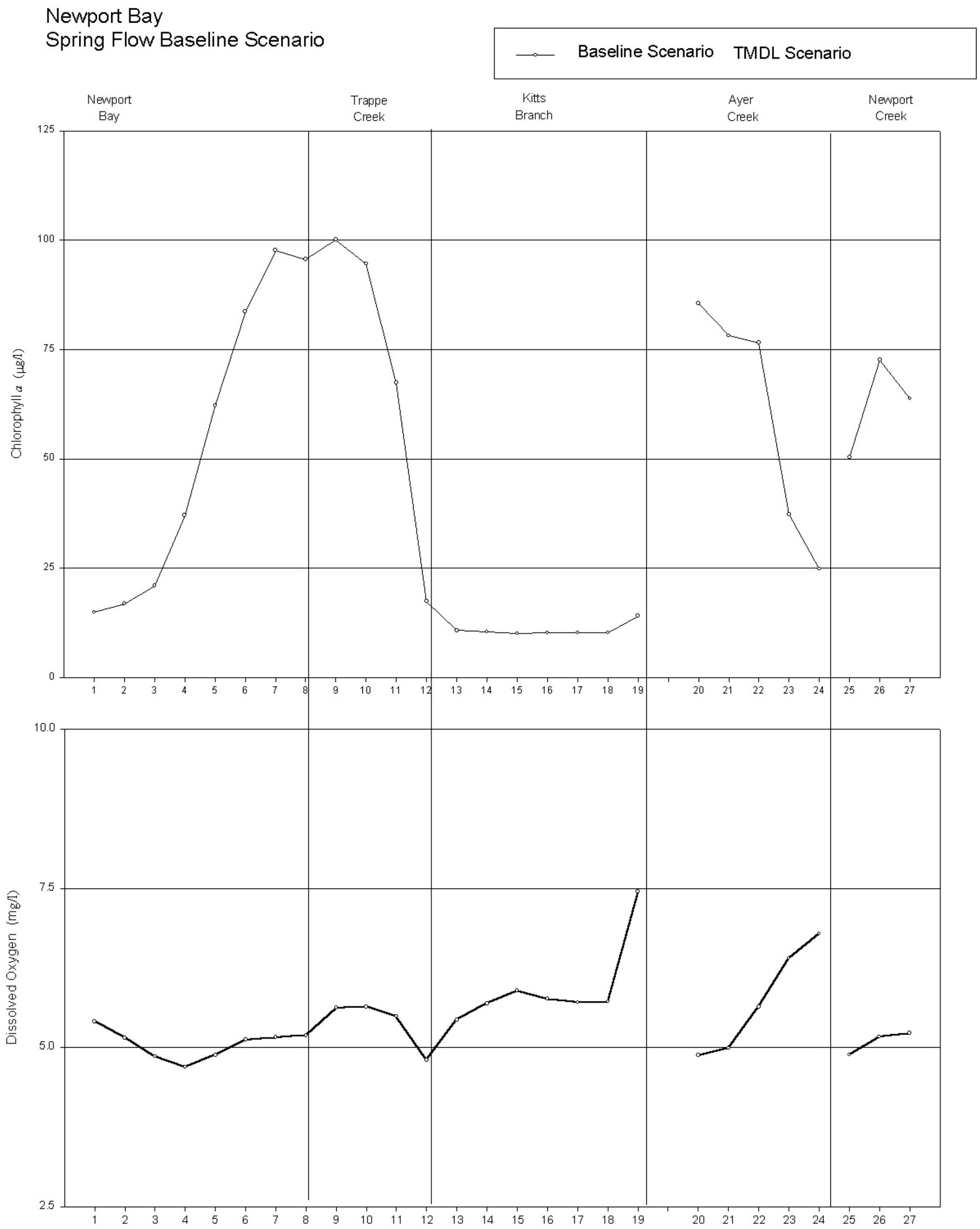


**Figure 11: Model Results for the Spring Flow Baseline Loading Condition Scenario for Chlorophyll *a* and Dissolved Oxygen at Sampling Stations 1 - 27 (Scenario 2)**

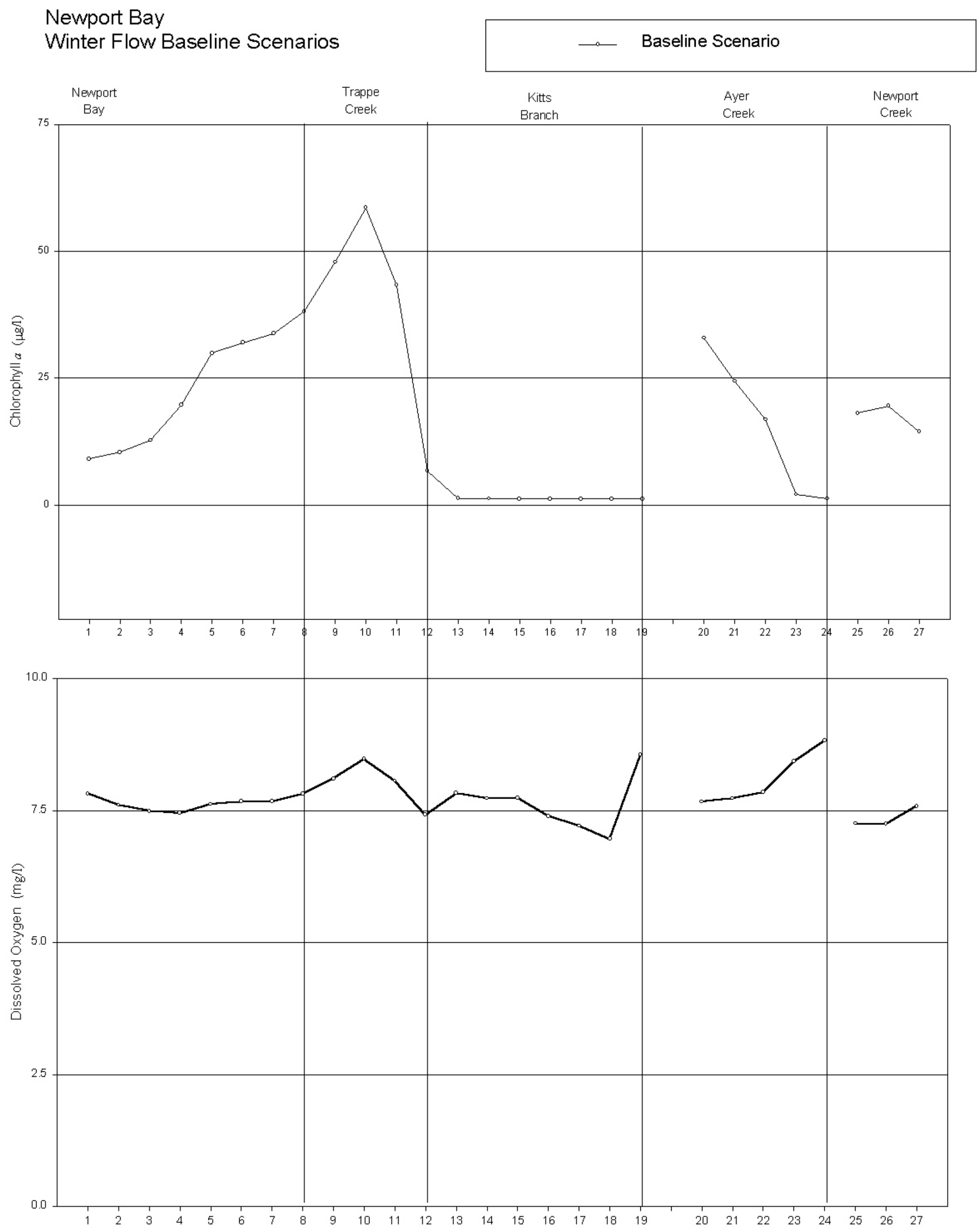


**Figure 12: Model Results for the Winter Flow Baseline Loading Condition Scenario for Chlorophyll a and Dissolved Oxygen at Sampling Stations 1 - 27 (Scenario 3)**

Future Condition Scenarios:

4. *Summer Flow:* Simulates the future condition of maximum allowable loads for critical low stream flow conditions during the summer season.

5. *Spring Flow:* Simulates the future condition of maximum allowable loads for average annual load conditions during the spring season.

6. *Winter Flow:* Simulates the future condition of maximum allowable loads for average annual load conditions during the winter season.

Scenario 4 Results: DO and chlorophyll *a* results for the fourth scenario, representing the maximum allowable loads for summer critical low flow, are summarized in Figure 13. Results for the Scenario 4 (dashed line) are summarized in comparison to the associated baseline Scenario 1 (solid line). Under the nutrient load reduction conditions described above for this scenario, the results show that chlorophyll *a* concentrations remain just below 50 μg/l in Trappe Creek. Peak values in Ayer Creek and Newport Creek are about 48 μg/l.

DO concentrations are predicted to shift upward as a result of simulated nitrogen reductions. The minimum DO values are predicted to be above the water quality goal of an average daily value of 6.0 mg/l and 5.3 mg/l simulated along the length of all the tributaries in the Newport Bay system. As previously indicated, the 6.0 mg/l goal is intended to account for a 1.0 mg/l diurnal DO swing for chlorophyll *a* level averaging above 50 μg/l, and 5.3 mg/l goal is intended to account for a 0.6 mg/l diurnal DO swing for chlorophyll *a* averaging below 25 μg/l.

Scenario 5 Results: DO and chlorophyll *a* results for the fifth scenario, representing the maximum allowable loads for spring-time critical high flow, are summarized in Figure 14. Results for the Scenario 5 (dashed line) are summarized in comparison to the associated baseline Scenario 2 (solid line).

Figure 14 presents the results for the entire Newport Bay system under the nutrient load reduction conditions described above for this scenario. The results show that chlorophyll *a* concentrations are predicted to shift downward from about a peak of 110 μg/l to about 50 μg/l in Trappe Creek and levels of 47 μg/l in Newport Creek and Ayer Creek.

Figure 14 shows that DO concentrations in the Newport Bay System are predicted to shift upward as a result of simulated nutrient reductions. The minimum DO values are predicted to be well above the water quality goal described above along the length of Newport Bay and all the tributaries.

Scenario 6 Results: DO and chlorophyll *a* results for the sixth scenario, representing the maximum allowable loads for winter-time critical high flow, are summarized in Figure 15. Results for Scenario 6 (dashed line) are summarized in comparison to the associated baseline Scenario 3 (solid line).

Figure 15 presents the results for the entire Newport Bay system under the nutrient load reduction conditions described above for Scenario 6. The results show that chlorophyll *a* concentrations are predicted to shift downward from a peak of about 60 µg/l to about 50 µg/l in Trappe Creek. The levels in the other tributaries were below 50 µg/l, prior to the reduction. The nonpoint source reduction of 45% is proposed in all tributaries due to the requirements of load reduction during summer and spring flow months.

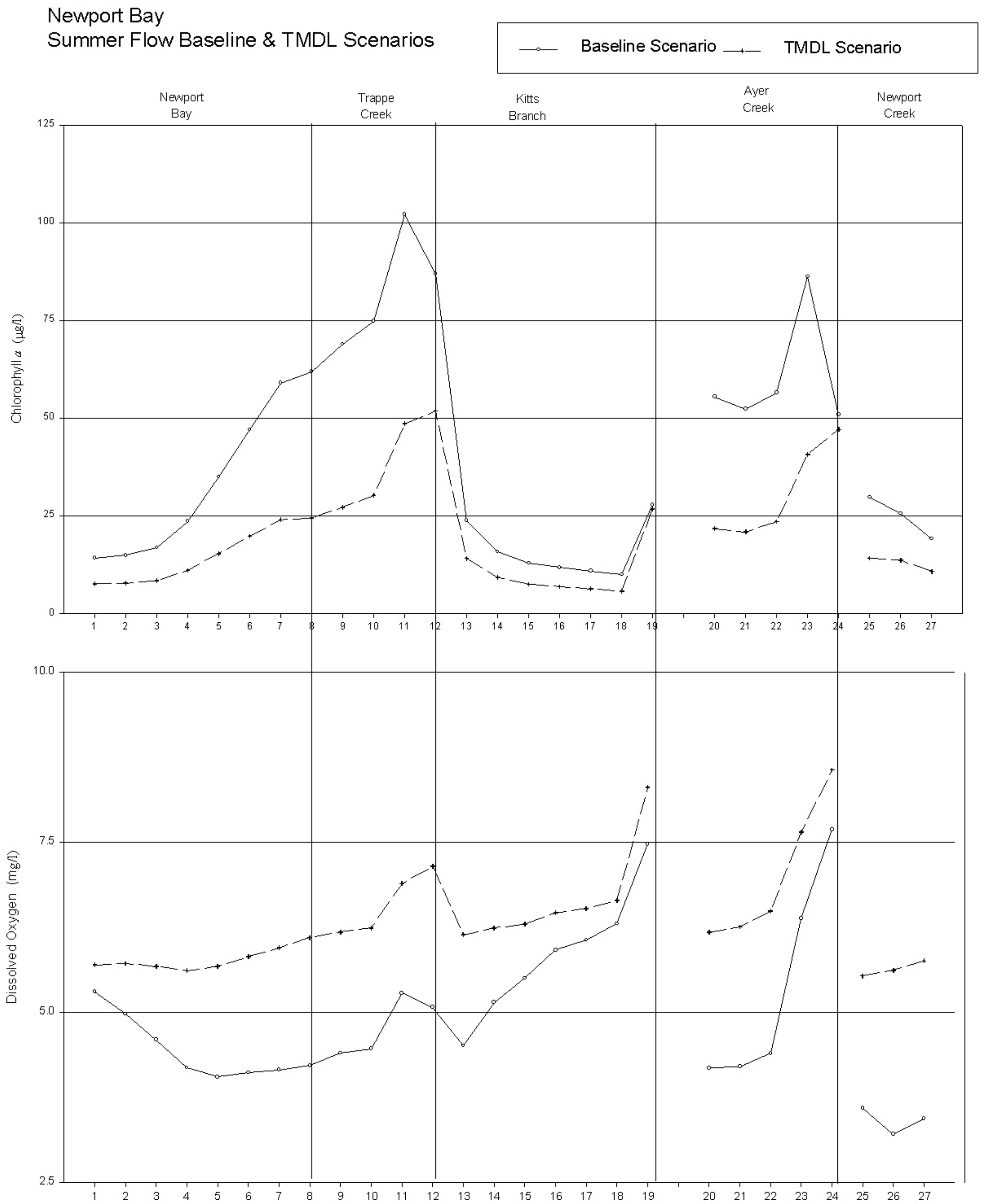


**Figure 13: Model Results for the Low Flow Future Condition Scenario for Chlorophyll *a* and Dissolved Oxygen at Sampling Stations 1 - 27 (Scenario 4)**

NOTE: The solid-line in Figure 13 represents the baseline water quality model result, and the dashed line represents the TMDL scenario result.

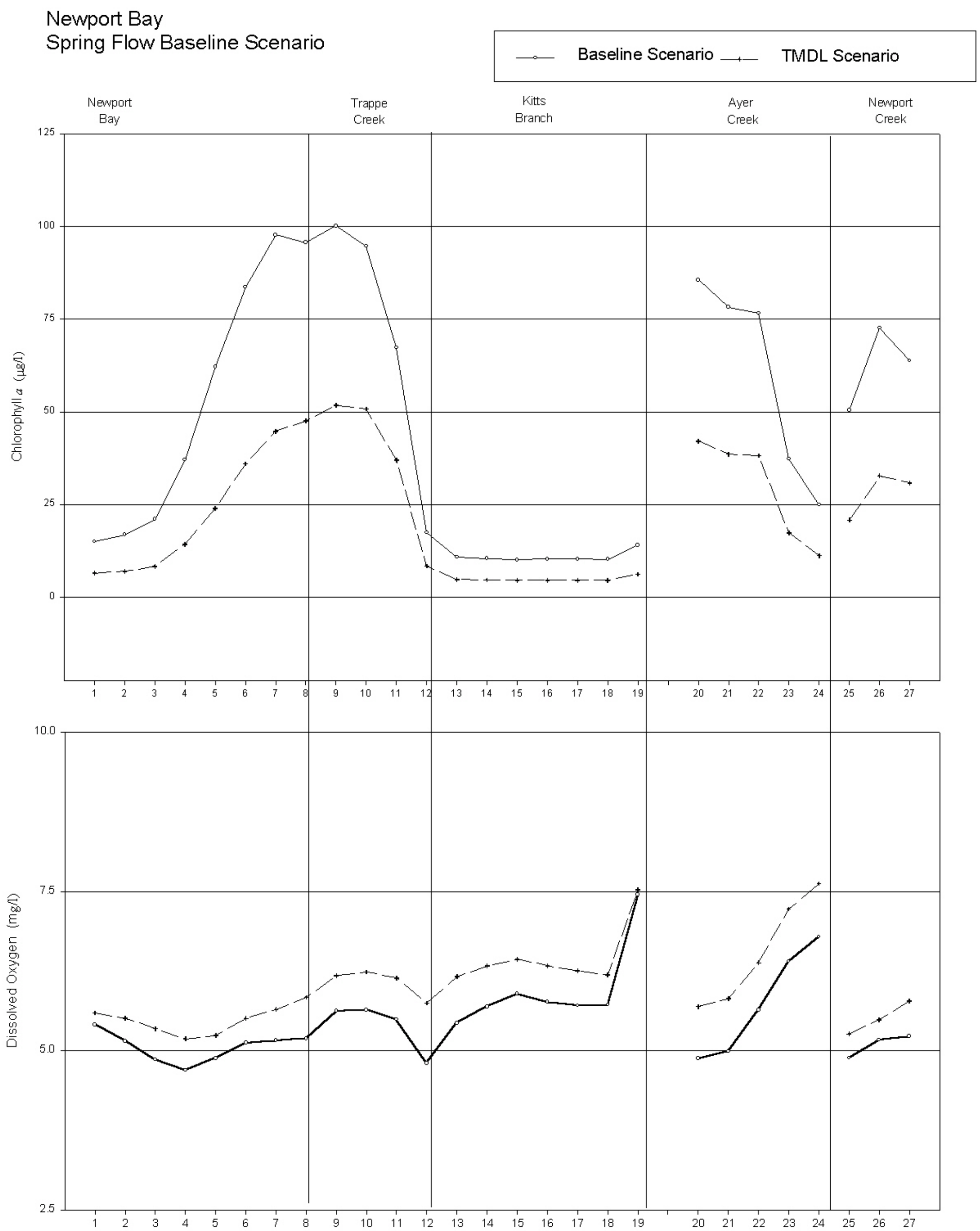


**Figure 14: Model Results for the Spring Flow Future Condition Scenario for Chlorophyll *a* and Dissolved Oxygen at Sampling Stations 1 - 27(Scenario 5)**

NOTE: The solid-line in Figure 14 represents the baseline water quality model result, and the dashed line represents the TMDL scenario result.

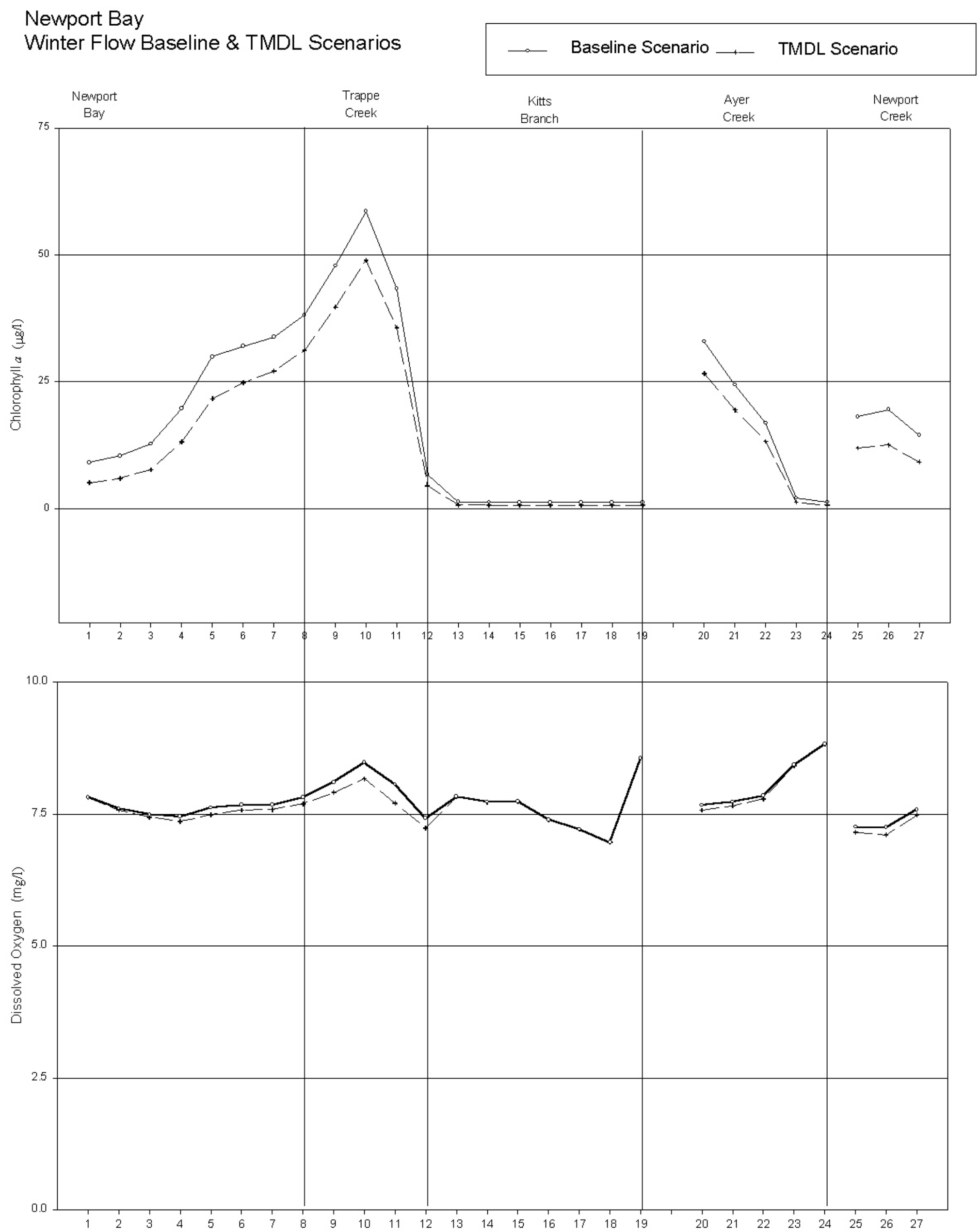


**Figure 15: Model Results for the Winter Flow Future Condition Scenario for Chlorophyll *a* and Dissolved Oxygen at Sampling Stations 1 – 27 (Scenario 6)**

NOTE: The solid-line in Figure 15 represents the baseline water quality model result, and the dashed line represents the TMDL scenario result.

### 4.5 TMDL Loading Caps

This section presents the TMDLs of nitrogen and BOD. Because the TMDLs set limits on nitrogen, and because of the way the model simulates nitrogen, it is not necessary to include an explicit TMDL for nitrogenous biochemical oxygen demand (NBOD).

The outcomes for the TMDL analyses are presented in terms of a critical summer flow TMDL, a spring flow TMDL and a winter flow TMDL. The critical season for excessive algal growth in Newport Bay is during the summer months when the river system is poorly flushed. During this critical time, sunlight and warm water temperatures are most conducive to creating the water quality problems associated with excessive nutrient enrichment. All the TMDLs are stated in monthly terms because they occur for different, limited periods of time. It should be noted that limits placed on spring flow loads and winter flow loads are accounted for indirectly in the summer flow TMDL by adjusting bottom sediment nutrient fluxes and SOD to be consistent with load reductions for these high flow periods (See Appendix A).

*Nitrogen TMDLs*

#### 4.5.1 TMDL Loading Caps for Nitrogen in Ayer Creek

The following TMDLs were developed on the basis of results from the WASP5.1 simulation model. The summer flow TMDL applies for the summer months, June 1 through October 31. The spring high flow TMDL applies for the spring months, April 1 through May 31. The winter high flow TMDL applies for the winter months, November 1 through March 31.

For the summer flow months, the following TMDL applies:

**NITROGEN TMDL** **215** ***lbs/month***

For the spring flow months, the following TMDL applies:

**NITROGEN TMDL** **1,824** ***lbs/month***

For the winter flow months, the following TMDL applies:

**NITROGEN TMDL** **2,085** ***lbs/month***

#### 4.5.2 TMDL Loading Caps for Nitrogen in Newport Creek

The following TMDLs were developed on the basis of results from the WASP5.1 simulation model. The summer flow TMDL applies for the summer months, June 1 through October 31. The spring high flow TMDL applies for the spring months, April 1 through May 31. The winter high flow TMDL applies for the winter months, November 1 through March 31.

For the summer flow months, the following TMDL applies:

**NITROGEN TMDL 280 *lbs/month***

For the spring flow months, the following TMDL applies:

**NITROGEN TMDL 2,194 *lbs/month***

For the winter flow months, the following TMDL applies:

**NITROGEN TMDL 2,886 *lbs/month***

### 4.5.3 TMDL Loading Caps for Nutrients in Newport Bay

The following TMDLs were developed on the basis of results from the WASP5.1 simulation model. It should be noted that these TMDLs include nutrient limits for Kitts Branch. Although Kitts Branch itself does not have a localized impairment, it does contribute to the downstream impairment of Trappe Creek and Newport Bay. The summer flow TMDL applies for the summer months, June 1 through October 31. The spring high flow TMDL applies for the spring months, April 1 through May 31. The winter high flow TMDL applies for the winter months, November 1 through March 31.

Model scenarios with and without the small nutrient load from the Newark WWTP show that it has no impact on Newport Bay. However, these permit requirements were established to protect Marshall Creek. Because Marshall Creek is not being addressed explicitly in the present analysis, the permitted limits on the Newark WWTP will remain in effect. They are reflected in the Newport Bay TMDL as part of the upstream background loads captured in the NPS load allocation of this TMDL. The limits on the Newark WWTP could be refined in the future when a TMDL analysis is conducted for Marshall Creek.

For period from June 1 through October 31

**NITROGEN TMDL 4,491 *lbs/month***

For the spring flow months, the following TMDL applies:

**NITROGEN TMDL 17,202 *lbs/month***

For the winter flow months, the following TMDL applies:

**NITROGEN TMDL 32,270 *lbs/month***

*BOD TMDL*

### 4.5.4 TMDL Loading Caps for BOD in Kitts Branch

The following TMDLs were developed on the basis of results from the WASP5.1 simulation model. The summer flow TMDL applies for the summer months, June 1 through October 31. The spring high flow TMDL applies for the spring months, April 1 through May 31. For Kitts Branch, a winter flow TMDL for BOD is not needed.

For the summer flow months, the following TMDL applies:

**BOD TMDL 1,369 *lbs/month***

For the spring flow months, the following TMDL applies:

**BOD TMDL 6,132 *lbs/month***

## 4.6 Load Allocations Between Point and Nonpoint Sources

The allocations described in this section demonstrate how the TMDLs can be implemented to strive toward achieving water quality standards in the Newport Bay system. The allocations address geographic distributions of allowable nutrient loads, as well as the distribution between point sources and nonpoint sources. These allocations demonstrate how these TMDLs could be implemented to achieve water quality standards; however the State reserves the right to revise these allocations provided the allocations are consistent with the achievement of water quality standards.

*Nitrogen TMDLs*

### 4.6.1 Load Allocations for Nitrogen in Ayer Creek

The watershed that drains to Ayer Creek has no permitted point source discharges of nutrients. Hence, for the low flow, the spring flow, and the winter flow TMDLs, the entire allocation, except for the MOS, is being made to nonpoint sources.

Low Flow Allocations:

The NPS loads of nitrogen and phosphorus simulated in the summer flow TMDL scenario (Scenario 4) represent reductions from the baseline scenario (Scenario 1). The baseline scenario loads were based on nutrient concentrations observed in summer 1998 and an estimated critical low stream flow (7Q10). These NPS loads account for both "natural" and human-induced sources. These loads cannot be separated into specific source categories, because they are based on observed in-stream concentrations. The nitrogen allocation for summer low flow conditions is presented in Table 1.

**Table 1: Summer Low Flow Allocations for Ayer Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 204 |
| Point Source | 0 |

Spring and Winter Flow Allocations:

The NPS loads of nitrogen simulated in the spring flow and winter flow TMDL scenarios (Scenario 5 & Scenario 6) represent the respective reductions from their baseline scenarios (Scenario 2 & Scenario 3). The spring flow baseline and winter flow baseline scenario loads were based on unit area loading rate estimates provided by a University of Maryland study (UMCES, 1993). These NPS loads account for both "natural" and human-induced sources. Further discussions of these loading estimates are provided in Appendix A. Details of a viable load allocation scheme are described further in the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*."

There are no permitted point source discharges of nutrients in the watershed. Consequently, the waste load allocations are set at zero. The nitrogen allocations for the spring flow TMDL and the winter flow TMDL are shown in Table 2 and Table 3, respectively.

**Table 2: Spring Flow Allocations for Ayer Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 1,733 |
| Point Source | 0 |

**Table 3: Winter Flow Allocations for Ayer Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 1,981 |
| Point Source | 0 |

### 4.6.2 Load Allocations for Nitrogen in Newport Creek

The watershed that drains to Newport Creek has no permitted point source discharges of nutrients. Hence, for all the proposed TMDLs, the entire allocation, except for the margin of safety, is being made to nonpoint sources.

Low Flow Allocations:

The NPS loads of nitrogen simulated in the summer flow TMDL scenario (Scenario 4) represent reductions from the baseline scenario (Scenario 1). The baseline scenario loads were based on nutrient concentrations observed in summer 1998 and an estimated critical low stream flow (7Q10). These NPS loads account for both "natural" and human-induced sources. These loads cannot be separated into specific source categories, because they are based on observed in-stream concentrations. The nitrogen allocation for summer low flow condition is presented in Table 4.

**Table 4: Summer Flow Allocations for Newport Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 266 |
| Point Source | 0 |

Spring and Winter Flow Allocations:

The NPS loads of nitrogen simulated in the spring flow and winter flow TMDL scenarios (Scenarios 5 & Scenario 6) represent the respective reductions from their baseline scenarios (Scenarios 2 & Scenario 3). The NPS load estimates for the spring flow and winter flow baseline scenarios were based on unit area loading rate estimates provided by a University of Maryland study (UMCES, 1993). These NPS loads account for both "natural" and human-induced sources. Further discussions of these loading estimates are provided in Appendix A. Details of a viable load allocation scheme are described further in the technical memorandum entitled "*Significant*

*Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*."

There are no permitted point source discharges of nutrients in the watershed. Consequently, the waste load allocations are set at zero. The nitrogen allocations for the spring flow TMDL and winter flow TMDL are shown in Table 5 and Table 6, respectively.

**Table 5: Spring Flow Allocations for Newport Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 2,084 |
| Point Source | 0 |

**Table 6: Winter Flow Allocations for Newport Creek**

| **Allocation Source** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Nonpoint Source | 2,741 |
| Point Source | 0 |

### 4.6.3 Load Allocations for Newport Bay

There are two significant major point source discharges of nutrients in the Newport Bay watershed and three other minor sources which contribute a fraction of load compared to the significant sources. The allocations described in this section demonstrate how the TMDLs can be implemented to achieve water quality standards in Newport Bay. Specifically, these allocations show that the sum of nutrient loadings to Newport Bay from existing point and nonpoint sources or anticipated land uses can be maintained safely within the TMDLs established here. The Newport Bay watershed includes Trappe Creek, Ayer Creek, Kitts Branch, Marshall Creek and Newport Creek.

Low Flow Allocations:

The NPS loads of nitrogen simulated in the fourth scenario represent reductions from the baseline scenario (Scenario 1). The NPS load estimates for the baseline scenario were based on nutrient concentrations observed in summer 1998 and an estimated critical low stream flow. These NPS loads account for both "natural" and human-induced sources and cannot be separated into specific source categories, because they are based on observed in-stream concentrations.

Point source load allocations for the summer flow TMDL make up the balance of the total allowable load. This point source load allocation was adopted from results of model Scenario 4. All significant point sources in the Newport Bay basin are addressed by this allocation and are described further in the technical memorandum entitled "*Significant Nutrient and Biochemical*

*Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*." The NPS and point source nitrogen allocations for summer low flow conditions are shown in Table 7.

**Table 7: Summer Flow Allocations for Newport Bay**

| Allocation Sources | Total Nitrogen *(lbs/month)* |
|---|---|
| Nonpoint Source | 3,451 |
| Point Source | 878 |

Spring and Winter Flow Allocations:

The NPS loads of nitrogen simulated in the spring flow and winter flow TMDL scenarios (Scenario 5 & Scenario 6) represent the respective reductions from their baseline scenarios (Scenario 2 & Scenario 3). The NPS load estimation for the spring flow and winter flow baseline scenarios were based on unit area loading rate estimates provided by a University of Maryland study (UMCES, 1993). These NPS loads account for both "natural" and human-induced sources. Further discussions of these loading estimates are provided in Appendix A. Details of a viable load allocation scheme are described further in the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*."

Point source load allocations for the spring flow TMDL and winter flow TMDL make up the balance of the total allowable load in the respective TMDLs. These point source load allocations were adopted from results of model Scenario 4 and Scenario 5. All significant point sources are addressed by this allocation and are described further in the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay Watershed.*" Table 8 shows the nitrogen load allocations to point and nonpoint sources for the spring flow TMDL. Similarly, Table 9 shows the nitrogen load allocations to point and nonpoint sources for the winter flow TMDL.

**Table 8: Spring Flow Allocations for Newport Bay**

| Allocation Sources | Total Nitrogen *(lbs/month)* |
|---|---|
| Nonpoint Source | 14,817 |
| Point Source | 1,626 |

**Table 9: Winter Flow Allocations for Newport Bay**

| Allocation Sources | Total Nitrogen *(lbs/month)* |
|---|---|
| Nonpoint Source | 21,506 |
| Point Source | 9,653 |

*BOD TMDL*

### 4.6.4 Load Allocations for Kitts Branch

There are two significant point source discharges for BOD in the Kitts Branch watershed. Nutrients generated in the Kitts Branch watershed do not cause a localized impairment to Kitts Branch itself. However, nutrients from Kitts Branch do contribute to impairments downstream in Trappe Creek and Newport Bay. Consequently, a nutrient TMDL is not being established for Kitts Branch, but loads from the Kitts Branch watershed are being limited as part of the nutrient TMDL for Newport Bay. The allocations described in this section demonstrate how the TMDLs can be implemented to achieve water quality standards in the Kitts Branch. Specifically, these allocations show that the sum of BOD loadings to Kitts Branch from existing point and nonpoint sources can be maintained safely within the TMDLs established here.

<u>Low Flow and Spring Flow Allocations</u>:

The NPS loads of nitrogen, and BOD simulated in the fourth and the fifth scenarios represent reductions from their respective base-line scenarios (Scenario 1 & Scenario 2). Point and NPS load allocations for the summer flow TMDL and the spring flow TMDL were adopted from results of model Scenarios 4 and Scenario 5, respectively. All significant point sources in the Kitts Branch are addressed by this allocation and are described further in the technical memorandum entitled "*Significant Nutrient and Biochemical Oxygen Demand Point and Nonpoint Sources in the Newport Bay System*." The nonpoint source and point source BOD allocations for summer flow conditions and spring flow condition are shown in Table 10 and Table 11, respectively.

**Table 10: Summer Flow Allocations for Kitts Branch**

| **Allocation Source** | **BOD *(lbs/month)*** |
|---|---|
| Nonpoint Source | 66 |
| Point Source | 1,300 |

**Table 11: Spring Flow Allocations for Kitts Branch**

| **Allocation Source** | **BOD *(lbs/month)*** |
|---|---|
| Nonpoint Source | 1,408 |
| Point Source | 4,650 |

### 4.7 Margins of Safety

A margin of safety (MOS) is required as part of a TMDL to account for uncertainties in the knowledge regarding the exact nature and magnitude of pollutant loads from various sources and the ability to predict impacts of those pollutants on the chemical and biological quality of complex, natural waterbodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

Based on EPA guidance, the MOS can be achieved through two approaches (EPA, April 1991). One approach is to reserve a portion of the loading capacity as a separate term in the TMDL (i.e., TMDL = WLA + LA + MOS). The second approach is to incorporate the MOS as conservative assumptions used in the TMDL analysis.

Maryland has adopted margins of safety that combine these two approaches. Following these approaches, the load allocated to the MOS was computed as 5% of the nonpoint source loads for nitrogen for all the TMDLs in the Newport Bay system. These explicit nitrogen MOSs for different waterbodies are summarized in Table 12, Table 13 & Table 14 below.

*Nitrogen TMDLs*

**Table 12: Margins of Safety for Low Flow Nitrogen TMDLs**

| **Waterbody Name** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Ayer Creek | 11 |
| Newport Creek | 14 |
| Newport Bay[1] | 164 |

[1] This summer flow TMDL applies only during the months of July, August and September.

**Table 13: Margins of Safety for Spring Flow Nitrogen TMDLs**

| **Waterbody Name** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Ayer Creek | 91 |
| Newport Creek | 110 |
| Newport Bay | 759 |

**Table 14: Margins of Safety for Winter Flow Nitrogen TMDLs**

| **Waterbody Name** | **Total Nitrogen *(lbs/month)*** |
|---|---|
| Ayer Creek | 104 |
| Newport Creek | 145 |
| Newport Bay | 1,111 |

*BOD TMDL*

The explicit MOSs for the BOD TMDL are listed in Table 15 and Table 16, below.

**Table 15: Margin of Safety for Summer Flow BOD TMDL**

| **Waterbody Name** | **Total BOD *(lbs/month)*** |
|---|---|
| Kitts Branch | 3 |

**Table 16: Margin of Safety for Spring Flow BOD TMDL**

| **Waterbody Name** | **Total BOD *(lbs/month)*** |
|---|---|
| Kitts Branch | 74 |

In addition to the explicit MOSs, additional conservative assumptions of the analysis provide implicit MOSs. The low flow TMDL analyses use a combination of environmental parameters (7Q10 flow, high solar radiation, high water temperature, all for a sustained period of time) that are conservative because these critical conditions are unlikely to occur simultaneously. Warmer water temperature and greater solar radiation are more conducive to algal growth and low DO concentrations. The spring flow TMDL analyses were conducted under the assumption of summer conditions, which represent conservative assumptions. Similarly, the winter flow TMDL analyses were performed using temperature conditions based on 10 years of data associated with a March time frame to simulate critical winter condition of algal growth, which is also a conservative assumption.

### 4.8 Summary of Total Maximum Daily Loads

The previous sections describe the modeling framework, the modeling scenarios and results in terms of TMDLs, load allocations, and the margins of safety. This section consolidates all of these results into a summary accounting of the TMDLs.

*Nitrogen TMDLs*

#### 4.8.1 Total Maximum Daily Loads for Ayer Creek

The following is the summer flow nitrogen TMDL, applicable from June 1 – Oct. 31, for the Ayer Creek.

**For Nitrogen (*lbs/month*):**

| | | | | | | |
|---|---|---|---|---|---|---|
| **TMDL** | = | **LA** | + | **WLA** | + | **MOS** |
| **215** | = | **204** | + | **0** | + | **11** |

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation (Nonpoint Source)
WLA = Waste Load Allocation (Point Source)
MOS = Margin of Safety

The following is the spring flow nitrogen TMDL, applicable from April 1 – May 31, for Ayer Creek.

**For Nitrogen (*lbs/month*):**

| | | | | | | |
|---|---|---|---|---|---|---|
| **TMDL** | = | **LA** | + | **WLA** | + | **MOS** |
| **1,824** | = | **1,733** | + | **0** | + | **91** |

The following is the winter flow nitrogen TMDL, applicable from November 1 – March 31, for Ayer Creek.

**For Nitrogen (*lbs/month*):**

| | | | | | | |
|---|---|---|---|---|---|---|
| **TMDL** | = | **LA** | + | **WLA** | + | **MOS** |
| **2,085** | = | **1,981** | + | **0** | + | **104** |

On average, the summer flow TMDL will result in loads of approximately 54 lbs/day of nitrogen, the spring flow TMDL will result in loads of approximately 61 lbs/day of nitrogen, and the winter flow TMDL will result in loads of approximately 70 lbs/day of nitrogen.

### 4.8.2 Total Maximum Daily Loads for Newport Creek

The following is the summer flow nitrogen TMDL, applicable from June 1 – Oct. 31, for Newport Creek.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **280** | = | **266** | + | **0** | + | **14** |

The following is the spring flow nitrogen TMDL, applicable from April 1 – May 31, for Newport Creek.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **2,194** | = | **2,084** | + | **0** | + | **110** |

The following is the winter flow nitrogen TMDL, applicable from November 1 – March 31, for Newport Creek.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **2,886** | = | **2,741** | + | **0** | + | **145** |

On average, the summer flow TMDL will result in loads of approximately 9 lbs/day of nitrogen, the spring flow TMDL will result in loads of approximately 73 lbs/day of nitrogen, and the winter flow TMDL will result in loads of approximately 96 lbs/day of nitrogen.

### 4.8.3 Total Maximum Daily Loads for Newport Bay

Recall that the Newport Bay watershed includes Trappe Creek, Ayer Creek, Kitts Branch, Marshall Creek and Newport Creek. Due to the Newark WWTP permit situation we have two TMDL numbers for the summer flow condition covering two different time periods.

The following is the summer flow nitrogen TMDL, applicable from June 1 – October 31 for Newport Bay.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **4,491** | = | **3,451** | + | **877** | + | **163** |

The following is the spring flow nitrogen TMDL, applicable from April 1 – May 31, for Newport Bay.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **17,202** | = | **14,817** | + | **1,626** | + | **759** |

The following is the winter flow nitrogen TMDL, applicable from November 1 – March 31, for Newport Bay.

**For Nitrogen (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **32,270** | = | **21,506** | + | **9,653** | + | **1,111** |

On average, the summer flow TMDL will result in loads of approximately 142 lbs/day of nitrogen, the spring flow TMDL will result in loads of approximately 573 lbs/day of nitrogen. and, the winter flow TMDL will result in loads of approximately 1,075 lbs/day of nitrogen.

*BOD TMDL*

### 4.8.4 Total Maximum Daily Loads for Kitts Branch

The following is the summer flow BOD TMDL, applicable from June 1 – Oct. 31, for Kitts Branch.

**For BOD (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **1,369** | = | **66** | + | **1300** | + | **3** |

The following is the spring flow BOD TMDL, applicable from April 1 – May 31, for Kitts Branch.

**For BOD (*lbs/month*):**

| TMDL | = | LA | + | WLA | + | MOS |
|---|---|---|---|---|---|---|
| **6,132** | = | **1,408** | + | **4,650** | + | **74** |

On average, the summer flow TMDL will result in loads of approximately 46 lbs/day of BOD, and, the spring flow TMDL will result in loads of approximately 204 lbs/day of BOD.

## 5.0 ASSURANCE OF IMPLEMENTATION

This section provides the basis for reasonable assurances that the nitrogen and BOD TMDLs will be achieved and maintained.

Maryland has several well-established programs to draw upon to assure implementation of the proposed TMDLs. These include the State's Nonpoint Source Management Programs under the Clean Water Act Section 319, the State's Coastal Nonpoint Pollution Control Programs under Section 6217 of the Coastal Zone Management Act, the Water Quality Improvement Act of 1998 (WQIA), the EPA-sponsored Clean Water Action Plan of 1998 (CWAP), the Comprehensive Conservation Management Plan for Maryland's Coastal Bays (CCMP) developed under Section 320 of the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permitting program under the Clean Water Act, and the Air Emmission Control Program under the Ammendment to Clean Air Act of 1990. In addition, significant work on evaluating the effectiveness of NPS Best Management Practices (BMPs) has been done by member states of the Bay Program. Based on this work, a technical manual is under development in Maryland, which will provide a consistent basis for detailed implementation planning (Refinement of the March, 1996 "Technical Appendix for Maryland's Tributary Strategies"). Finally, Maryland has adopted procedures to assure that future evaluations are conducted for all TMDLs that are established.

<u>Federal Clean Water Act Section 319 Nonpoint Source Management Programs</u>: The Section 319 Program represents a comprehensive framework for managing nonpoint sources of pollutants. The program supports assessments and reporting of waters of the State that are impaired by nonpoint sources, the documented coordination of a wide array of State programs that jointly constitute a comprehensive nonpoint source management strategy, and the administration of a grant program for the funding of nonpoint source management activities.

<u>Federal Coastal Zone Management Act (CZM) Coastal Nonpoint Pollution Control Programs</u>: The backbone of the CZM Section 6217 program is the application of management measurements. The 6217 program in Maryland relies on 56 separate management measures for various land use practices. Each management measure has associated enforceable policies and mechanisms (or backup authority) to ensure implementation. If these original management measures fail to produce the necessary water quality improvements, additional management measures must be implemented to address remaining water quality problems.

<u>Federal Clean Act Act Section 106 Air Emission Control Program</u>: The Section 106 Management measures are defined as measures to control the addition of various contaminants (sulphur dioxide, nitrogen dioxide and lead) to air. These measures will result a substantial reduction in the air pollution, consequently to the loads to the watershed as atmospheric deposition. The measures take into account emissions control from utility, industrial, and mobile source sectors.

Also Section 109 of Clean Air Act makes sure that all the neighboring states of the watershed are participating with each other to reduce interstate pollution.

CZM 6217 management measures focus on five major categories of nonpoint source pollution:

- Agricultural runoff
- Urban runoff
- Silvicultural (forestry) runoff
- Marinas and recreational boating
- Stream channelization and channel modification, dams, and streambank and shoreline erosion.

The state has also developed management measures for wetlands, riparian areas, and vegetated treatment systems that apply generally to various categories of nonpoint source pollution.

The federal program requires that each state program have enforceable policies and mechanisms for most of the management measures, this insures the authority to implement the BMPs. The state is also required to track the program's implementation and effectiveness. A tracking system is currently under development.

State Water Quality Improvement Act (WQIA): Maryland's WQIA requires that comprehensive and enforceable nutrient management plans be developed, approved and implemented for all agricultural lands throughout Maryland. This act specifically requires that nitrogen management plans be developed and implemented by 2004, and plans for phosphorus be implemented by 2005. In support of this, and other agricultural water quality management efforts, Maryland's Agricultural Cost Share Program (MACS) funding is available for Best Management Practices (BMPs) in this watershed. Similarly, the Low Income Loans for Agricultural Conservation (LILAC) program is available to provide financial assistance.

Federal Clean Water Action Plan (CWAP): Maryland's CWAP initiative has been implemented in a coordinated manner with the State's 303(d) process for identifying impaired waters. All Category I watersheds identified in Maryland's Unified Watershed Assessment process under the CWAP coincide with the approved 303(d) list of impaired waters for 1998. The State has given a high-priority for funding assessment and restoration activities to these watersheds. In coordination with local governments, Maryland has recently conducted and documented a watershed characterization for Isle of Wight Bay (Shanks, 2001). An associated Watershed Restoration Action Strategy (WRAS) is presently under development.

Federal Clean Air Act Action Plan: Under Chespeake Bay agreement an action plan is being developed to reduce the atmospheric deposition of nitrogen from its airshed. Currently the air pollution prevention and control actions on the state level has provided a great deal of support to this extent. Maryland has its own air emission control program to support the reduction in atmospheric deposition to the lands of the state. Newport Bay watershed falls within the airshed of the Chesapeake Bay watershed, hence any advantage achieved on the Chesapeake Bay directly affects the atmospheric load reduction in the Newport Bay Watershed. Our claim regarding reductions to "direct deposition to the surface of the estuary" is thus consistent with the reduction strategy as proposed on Chesapeake 2000 agreement. The expected 20% reduction can be achieved if the CAA is fully implemented.

Additionally, this TMDL provides a great deal of incentive for the CAA to be fully implemented.

Maryland Coastal Bays Program (MCBP): In 1999 the Maryland Coastal Bays Program (MCBP) released its Comprehensive Conservation Management Plan (CCMP) for Maryland's Coastal Bays (MCBP, 1999). The MCBP was created in 1996 to assist the region in developing a comprehensive plan to restore and protect Maryland's Coastal Bays. The Program is a partnership among the towns of Ocean City and Berlin; Worcester County; Maryland's Departments of Natural Resources, Agriculture, Environment, and Planning; U.S. National Park Service; and the U.S. Environmental Protection Agency. The CCMP delineates goals, actions needed to complete those goals, and strategies needed to complete each action for four different areas: water quality, fish and wildlife, recreation and navigation, and community and economic development. The water quality goals and actions will help assure that nutrient control activities are targeted to areas where nutrient TMDLs have been established.

Federal National Pollutant Discharge Elimination System: The implementation of point source nutrient controls will be executed through the use of NPDES permits. The NPDES permits will have compliance provisions, which provide a reasonable assurance of implementation.

Assured Future Evaluations: Finally, in 1998, Maryland adopted a five-year watershed cycling strategy to manage its waters. Pursuant to this strategy, the State is divided into five regions and management activities will cycle through those regions over a five-year period. The cycle begins with intensive monitoring, followed by computer modeling, TMDL development, implementation activities, and follow-up evaluation. The choice of a five-year cycle is motivated by the five-year federal NPDES permit cycle. This continuing cycle ensures that, within five years of establishing a TMDL, intensive follow-up monitoring will be performed. Thus, the watershed cycling strategy establishes a TMDL evaluation process that assures accountability.

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# Appendix A

# Appendix B